# INDUSTRIAL SAFETY ORGANIZATION

FOR

# EXECUTIVE AND ENGINEER

BY

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There is nothing under God's Heaven that justifies your creation or your citizenship but this gospel—that the next greatest thing to creating a life is to save a life.

CHARLES E. WOODCOCK

# PREFACE

Although a number of books on accident prevention have appeared since the safety movement became a vital force in American industrial life, this is perhaps the first attempt to deal intimately and at length with the basic principles of safety organization. Industrial safety is still in its adolescence—the late formative period—undergoing expansion, rationalization and the preliminary stages of standardization. While it has emerged from the "movement" phase and is gaining its permanent status, the literature of safety, already surprisingly profuse (and no less diffuse!), is scattered through an immense range of periodicals, "house organs," codes, regulations, rule books, bulletins and the transactions of technical and trade associations. These and other circumstances, which it is not necessary to relate, have made the preparation of the manuscript, extended now over a period of three years, an undertaking beset with difficulties.

The future progress of the safety movement, the decision whether it shall advance with sufficient speed and strength to enable it to overtake the apparent increase in industrial accidents for which mass production and mechanical methods are largely responsible, rests with three groups: industrial executives, the engineering fraternity and that smaller and newer group, the safety engineers. I have named them in what I believe to be the order of their importance as factors controlling the destiny of industrial accident prevention. It is for them that this volume has been written.

The preparation of a book that may be acceptable and helpful to three different professional groups is no easy matter. I can only hope that my readers who are inclined to find it—variously—too elementary, too technical, or overburdened with the jargon of the safety enthusiast will be patient and forbearing, and so may be able to derive from it a somewhat clearer understanding of the safety movement and, in some instances, inspiration and help to undertake or carry on safety work to the point of successful issue.

Fourteen years of accident prevention work in the duPont Company, where safety organizations were developed from modest beginnings in numerous small plants to full-fledged safety departments competent to function satisfactorily in huge war-time establishments—these later to pass through successive stages of retrenchment and reexpansion—has permitted a broad survey of safety systems and methods, successful and otherwise. This company, originally only a small manufacturer of explosives, has become the country's largest chemical industry. The interest of its officers in accident prevention, founded on the almost historic concern of the company for the welfare of its employes, and the liberality of their point of view has given opportunity for much trial and experiment. Only this and the endless inspiration and encouragement derived by the author from years of intimate association with and in the National Safety Council have made the preparation of this book possible.

In what we term "the safety game," no move actuated by selfish motives carries forward and, as in all human enterprise, it is ignorance, stupidity and self-seeking that hold back progress. Among its many beautiful aspects, there is none that lends the safety movement more grace than the give-and-take spirit. Safety rests upon a basis of cooperation and free interchange of thought and favor. With this in mind, I have felt at liberty to borrow freely from the experience and theories of others. But from the hundreds of able and seasoned safety workers, many of them personal friends, who stood ready and willing to give of their experience (often dearly bought), I have been forced to select only a few—usually those who had already written or said what seemed pertinent to the subject in hand. To all of these my thanks are due.

It is also fitting that I should express my gratitude to the various national organizations, federal and state departments, and industrial establishments for their valuable assistance, to the publishers who have courteously permitted the use of copyrighted matter, to the duPont Company for much time and the use of its facilities, and lastly but with much fervor, to my able critics, William H. Cameron, Albert W. Whitney and Sidney J. Williams.

Notwithstanding these many favors my greatest debt of gratitude is to those whose own effort to bring about the saving of life from industrial accidents has been a constant inspiration

to me, not only during the preparation of this volume, but throughout my accident-prevention experience—and a help over the hard places which those who set out upon new paths must expect to find. Were it customary to formally dedicate a book of this sort, I should unhesitatingly dedicate it to them—to those earlier pioneers who, when industrial accident prevention seemed to others mere Utopianism, inspired in their belief, unshaken in their faith, guided (I like to think) unknowingly by that earlier Great Example, founded the National Safety Council, nurtured it, cherished it and piloted it through the many vicissitudes of its career. They were the true guardians of the safety movement—guardians of industrial life itself—known to their friends and allies as "The Old Guard."

LEWIS A. DEBLOIS.

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## CHAPTER I

### THE INDUSTRIAL ACCIDENT SITUATION—NATIONAL AND GROUP EXPERIENCE

> And the end is that the workman shall live to enjoy the fruits of his labor; that his mother shall have the comfort of his arm in her age; that his wife shall not be untimely a widow; that his children shall have a father, and that cripples and helpless wrecks who were once strong men shall not longer be a by-product of industry.

This is the purpose of the industrial safety movement, admirably expressed by P. B. Juhnke. It is its justification in terms of what we account most precious in life and is, emotionally, satisfying and complete. But industry is conducted on an economic basis—not upon an emotional basis. The survival of new arrivals in the industrial world, of which safety is one, is conditioned on their economic fitness rather than upon their emotional appeal. Consequently, if industrial safety is to survive and prosper, it must prove its economic worth.

It is true that many eminent industrial executives have declared themselves satisfied with the results of safety work on their plants if one employe has been saved from accidental death, but there are others whose actions are less profoundly influenced by their emotions, whose sense of obligation to society is less keen, and many who, though feeling the humanitarian impulse, seek some measure of economic justification before embarking upon a campaign of intensified accident prevention.

The more prominent industrial executives do not own their own business; they are but the paid servants of their stockholders and must, theoretically at least, furnish an accounting of their stewardship. On the other hand, executives of small industrial

concerns (which include 70% of the country's industrial establishments), who are frequently owners or part owners, have comparatively slender reserves on which to draw for "new improvements" and, in addition, must meet the exigencies of close competition. Merely to tell such men that "safety is a good thing" is quite insufficient—indeed, they know it already. They must be shown that safety is an investment that will not only carry itself, but will yield a reasonable return. They must also be made to realize the seriousness of the accident situation as revealed by accident statistics. Such is the purpose of this and the following chapter.

**National Accident Statistics.**—In 1923 there were 84,624 accidental fatalities in the United States. About 22,600 were street and highway fatalities; 20,000 are estimated to have been home accidents; 23,000 are thought to have been industrial accidents; and the balance, about 19,000, were the result of drowning, fires, firearms, falls, electricity and other causes not obviously assignable to industry or the home but usually included with street and highway accidents under the caption "Public Accidents."

The figure of 23,000 accidental industrial deaths is an estimate made for the year 1919 by F. S. Crum, Assistant Statistician of the Prudential Insurance Company.[1] Unfortunately the system by which causes of death are reported by state boards of health, or their equivalent, to the Bureau of the Census does not permit the separation of occupational deaths, while the lack of uniformity in the methods used by individual states in requiring the reporting of industrial accidents makes it impossible to compile national statistics from such sources. Consequently only estimates are possible.

A somewhat later estimate by Carl Hookstadt[2] for the year 1923 gave 21,232 accidental deaths. Using the American (Outwater) and Standard (Rubinow) Accident Distribution Tables, to which he applied certain corrections of his own, Hookstadt obtained the following distribution of industrial accidents:

[1] "Public Accidents and Their Cost," *Proc. Nat. Safety Council*, Eighth Annual Safety Congress, p. 1061, Chicago, 1919; and "Report of Committee on Statistics," *Proc. Nat. Safety Council*, Ninth Annual Safety Congress, 321, 1920.

[2] "Estimated Annual Number and Cost of Industrial Accidents in the U. S.," *Monthly Labor Rev.*, U. S. Bur. Labor Statistics, **17**, 5, p. 991,

| | |
|---|---|
| Deaths | 21,232 |
| Permanent total disability cases | 1,728 |
| Permanent partial disability cases | 105,629 |
| Temporary total disability cases[1] | 2,324,829 |
| | 2,453,418 |

[1] Accidents resulting in loss of time from work other than the day on which injury occurred.

Hookstadt calculated that this was equivalent to a loss of 227,169,970 working days or $1,022,264,866 in wages.

**Waste from Accidents.**—In 1919 a very comprehensive and painstaking study of industrial waste in the United States was conducted by the Committee on the Elimination of Waste in Industry of the Federated Engineering Societies. Waste due to accidents was subjected to careful scrutiny by Sidney J. Williams, Chief Engineer of the National Safety Council, who is authority for the following statements:

In 1919 there occurred in industry about 23,000 fatal accidents, about 575,000 non-fatal accidents causing 4 weeks or more of disability, and 3,000,000 accidents causing at least 1 day's disability. The figures for 1918 were about 13% higher. The time lost is estimated to be 296,000,000 days. Allowing for an average wage of $4 per day during the time actually lost, adding an estimate for impaired earning power because of disability or death, but subtracting the subsistence of those killed, this gives an economic loss to the country of about $853,000,000 for the year 1919.

This is not the whole loss chargeable to accidents. In one state (Wisconsin) the costs to employers for medical and surgical aid and hospital bills, and the overhead expenses of insurance, equaled 86% of the actual compensation paid to workmen. The compensation paid the workmen was about 22% of the total actual and prospective wage loss. Records from other states indicate that this is probably typical. On this basis the total direct cost of industrial accidents in the United States in 1919, including medical aid and insurance overhead, was not less than $1,014,000,000. Of this, $349,000,000 was borne by employers and $665,000,000 by employes and their dependents.

These approximate figures are low because they do not include medical expenses incurred by workmen and not paid by the employer or insurance company; overhead cost of personal accident insurance carried by workmen; cost of training new men to take the place of those injured; employment and welfare department expense in keeping track of injured workmen and their families. The addition of these items would bring the total well over a billion dollars per year.

In this calculation no account has been taken of the indirect loss of production due to the stoppage or slowing up of work when an accident occurs. This affects not only the operation at which the man is injured, but associated operations as well. It applies also to "near-accidents" in which no personal injury occurs.

Experience indicates, and authorities agree, that 75% of these losses could be avoided, with a saving in direct, clearly ascertained losses alone of a quarter of a billion dollars per year to employers, and half a billion to employes.[1]

The divergence between the estimates of Williams and of Hookstadt is relatively unimportant; the outstanding fact is the hugeness of the vital and ecomonic waste from industrial accidents which, if to an appreciable extent avoidable, constitutes a national disgrace. Seven per cent of the 42,000,000 persons gainfully employed are injured each year, and the entire working population pays annually for industrial injuries a tax on its earnings which has been variously estimated at 2 to 4%!

In the state of New York, during 12 months ending July 30, 1925, there were 72,983 compensation awards for industrial injuries.[2] $32,898,166 represented the value of compensation and medical benefits furnished the workers, but they also suffered a loss in wages estimated to be $24,300,000. The direct and immediate loss was therefore divided between the employers and the workers in the proportion of 57 to 43, though it may be surmised that part of the employes' loss was eventually passed on to employers and that the employers' share was ultimately paid by the purchasers of their products. There was, in addition, an expense item of $16,400,000 for state administration and insurance. Of the total $73,598,166 accident cost, the workers paid 32% through direct losses and the remaining 68% was paid ultimately by the citizens at large. This would be equivalent to a per capita tax of about $5.30 on the total population or $12.80 on that part of the population which was gainfully employed. These figures exclude, of course, many intangible items of loss.

While industry, meaning thereby both employer and employed, pays the national bill for accidents, the ultimate financial burden

[1] Committee on Elimination of Waste in Industry of the Federated Engineering Societies, "Waste in Industry," p. 22, McGraw-Hill Book Company, Inc., 1920.

[2] Hamilton, James A., "Cost of Compensation for Industrial Accidents," *New York Industrial Bull.*, p. 212, Albany, N. Y., June, 1925.

PLATE I.—Safety Trophy—Carnegie Steel Company. (*National Safety Council.*)

(*Facing page 4*)

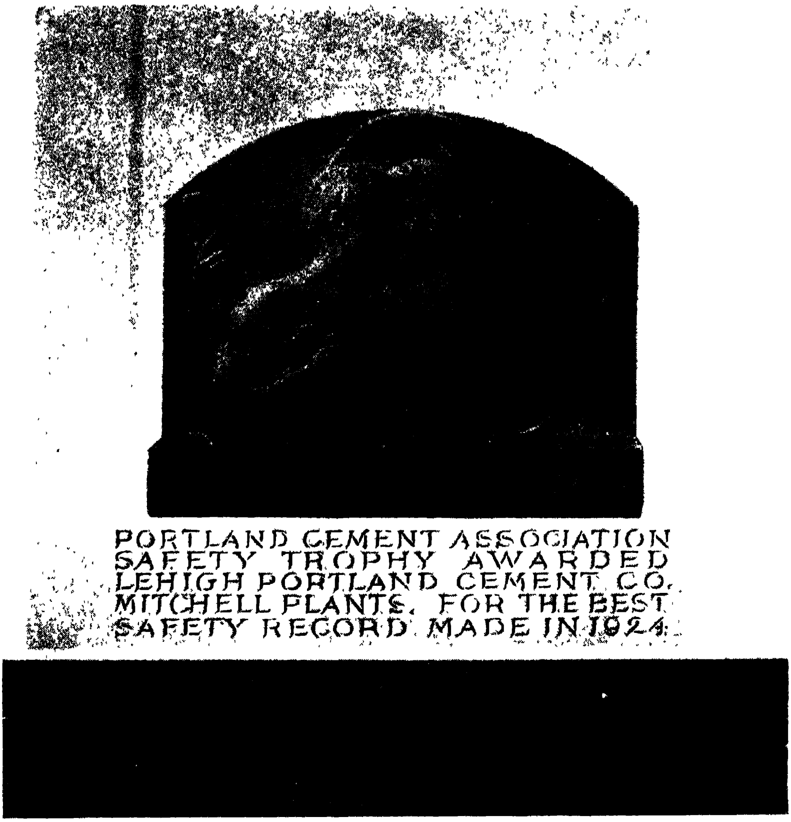


PLATE II.—Safety Trophy—Portland Cement Association. (*National Safety Council.*)

(*Facing page 5*)

is shared by the purchasers of industrial products, the taxpayers at large and the philanthropist who aids in the support of hospitals and other charities. In fact the latter, if he chances to be also a "captain of industry," may be called upon to defray the expense of industrial accidents in at least four different ways.

Nor should it be assumed that the burden is either equally distributed or remains constant; in some industries injury frequency is exceedingly high and in others exceedingly low.[1] The relative distribution of the more costly types of accidents, deaths and permanent disabilities, varies among industries: The explosives industry, for example, has a higher death rate and a lower temporary disability injury rate than certain other so-called hazardous industries. Compensation and medical expenses for a given type of injury vary from state to state and, with them, compensation insurance rates.

Compensation insurance rates show a marked tendency to increase rather than diminish, due largely to rising wage levels and the enactment of more liberal compensation laws, as well as to continued unfavorable insurance experience, which at the present time shows heavy losses in many states. Indeed, the rates would be even higher if it were feasible for the insurance companies to base their petitions for rate increases on current experience instead of experience 2 years old, and if such increases were always allowed by the state insurance commissioners. Incidentally, we must not forget that liability insurance in all its forms is nothing more than a convenient method of handling the payment of a cost subject to violent fluctuation. It in no way relieves the employer of his share of the expense of industrial accidents.

As the cost of the average industrial accident is increasing from year to year and will continue to increase with advances in wage rates and more liberal compensation provisions, additional expense to industry will be entailed and, in the last analysis, to the nation, unless offset by a proportionate accident reduction.

**Measures of Accident Reduction.**—Subsequently in this chapter four measures of accident reduction will be referred to:

1. Accident mortality rate.
2. Fatality frequency rate, called *fatality rate*.

[1] Compare the fatal accident rate given by Hookstadt of 5.73 for electric light and power public utilities with 0.01 for the manufacture of tobacco (*loc. cit.*, p. 995).

3. Injury frequency rate, called *frequency rate.*
4. Injury severity rate, called *severity rate.*

A complete definition of these rates and the method of computing them will be found in Chap. VIII, but it is necessary to provide a brief explanation here for the benefit of those who are not familiar with them.

Accident mortality rates, fatality rates and frequency rates express the average frequency with which accidents occur during the period covered (usually a year). Accident mortality and fatality rates include only cases terminating in death, while the frequency rate includes both fatal injuries and non-fatal injuries. In industrial accident statistics, there are included only accidental injuries which arise from the employment and occasion loss of time from work other than the remainder of the day on which the injury occurred.

The severity rate is an injury frequency rate weighted for the relative severity of the injuries that have occurred. Weighting is applied on the basis of time lost from work, actual lost time being used in the case of temporary disability injuries, but for death and permanent disability cases an empirical figure is applied from a nationally accepted table of weights. The weights in question have been formulated on the basis of useful life expectancy and its proportionate impairment by amputation or loss of function. The weight for death is 6,000 days.

The computation of accident rates requires the adoption of a standard basis, which is properly a unit of exposure to injury. For federal and state accident mortality rates the usual unit is 100,000 of population, but in the industrial world the unit of exposure for fatality, frequency and severity rates is some function of the number of payroll employes or the number of hours worked. The latter furnishes the more precise basis and is the accepted national standard, the base for frequency rates being 1,000,000 hours worked and for severity rates 1,000 hours worked.

There is a fifth measure of accident experience which will be referred to frequently in the following chapter: *no-accident records* or *number of days without an accident.* This is the working period during which the frequency rate has been maintained at zero. It is a useful though somewhat loose standard of comparison for plants of nearly equal size and equivalent hazards which have made distinct progress in reducing their frequency rates.

**National Accident Reduction.**—Since our whole knowledge of the national industrial accident situation rests perforce on assumptions and approximations, it is impossible to say with any certainty that industrial accident rates in the United States have been materially decreased. That the trend is downward in some industries has been demonstrated beyond question, but

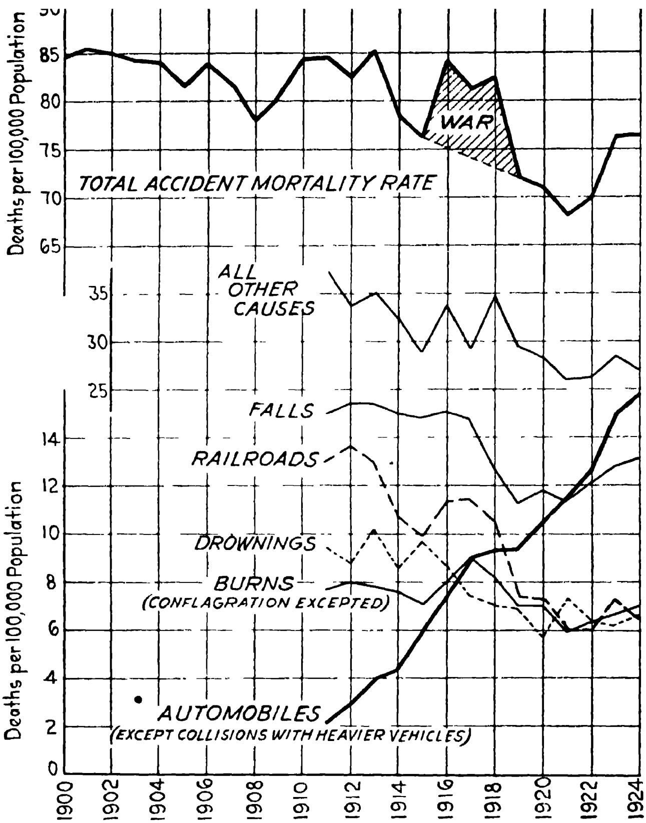


FIG. 1.—Accident mortality rates for registration area of continental United States.

whether this has yet offset the upward trend in other industries is a matter still in doubt.

Some interesting deductions of a general nature may be drawn from the mortality statistics of the Bureau of the Census which are based on the international list of causes assigned on death certificates. In Fig. 1 the accident mortality rates for the

registration area of continental United States are shown in three sets of curves: total rate, five principal causes, and "all other causes." Different vertical scales are used for the three sets but each expresses the number of deaths per year per 100,000 of estimated midyear population.

It will be observed that the total rate suffered a general decline from 1901 to 1908, followed by rise to a peak of 85.3 in 1913. In the next 2 years the rate fell rapidly, increased again in 1916, 1917 and 1918 and finally reached its minimum of 68.2 in 1921. This was followed by marked increases in 1922, 1923 and 1924.

By employing some degree of imagination, the curve during the years 1916, 1917 and 1918 may be viewed as the sum of a high rate increment due to wartime activities superimposed upon a progressive decline commenced in 1913 and maintained until 1921. This assumption, not supported by any facts, is indicated by the shaded portion of the upper curve in the figure.

The National Safety Council was not organized until October, 1913, but the accident prevention movement in this country was by that time already under way. That a marked decline should have commenced then (if we make allowance for the war years) is interesting and perhaps significant. It has been estimated[1] that, if the rate of 1907 (the lowest for the 14-year period, 1900 to 1913) had maintained from 1908 to 1923 inclusive, approximately 240,000 more accidental deaths would have occurred and several million additional non-fatal injuries. If any such saving did actually occur, what part of it could be attributed to the growth of the safety movement and what to the enactment of compensation laws and to improved living and working conditions, better education and more perfect health, no one can say.

If we study the rates for specified causes (shown in the lower part of the figure), we note marked increases during war years in "railroads" and "burns," a lesser increase in "falls," no increase in "drowning" and rather erratic behavior in the curve for "all other" causes. In the case of "automobiles," there is no real peak during war years but the continuation of the high rate of rise established in 1915 to 1917 was apparently interrupted in 1918 and 1919 and only resumed thereafter. These changes all appear to be what we should logically expect.

Conversely, during the period 1913 to 1921 other accidental death causes, not shown in the figure, which should have been but little affected by the safety movement were accompanied by no marked decline in the then reported mortality rate.

The principal causes of the increase in the total rate from 1922 to 1924 are obviously "automobiles" and "falls." The reason for the increase in the latter is not clear, though it may be conjectured that a large proportion of such accidents occur on the streets, in public buildings and in the homes rather than in industry, and that the mortality is particularly high among those advanced in years but few of whom are industrially employed.

So far as concerns the general accident mortality rates shown in the figure, it should be clearly understood that they are based on total population and therefore do not indicate the trend of industrial rates, since it is necessary to base the latter upon only that part of the population which is industrially employed. Moreover, days of work as well as the number employed would directly affect the frequency and severity rates. In this connection, it should be noted that the "general index of employment in manufacturing industries" as compiled by the U. S. Bureau of Labor Statistics increased from 1921 to 1923, indicating a probable increase in total exposure to industrial accidents. This increase would be sufficient to offset a considerable increase in the actual number of industrial deaths.

**Accidents as Reported by States.**—There is a total lack of uniformity in the reporting of industrial accidents by the several states. Six states make no reports; one state reports only coal mine accidents; other states report compensable accidents only. Practice in reporting coal mine accidents and railroad accidents varies widely, and throughout there exists the possibility of duplication, on the one hand, and non-reporting, on the other.

Table I, showing the number of accidental industrial fatalities reported by the states, is derived from a recent study by the U. S. Commissioner of Labor Statistics.[1]

The figures for separate states are not comparable and the totals of the columns are meaningless and therefore are not quoted. The table is here presented because it does give some indication of a general upward trend of fatal accidents as reported

TABLE I.—NUMBER OF FATAL INDUSTRIAL ACCIDENTS REPORTED BY THE SEVERAL STATES

| | 1921 | 1923 | 1924 |
|---|---|---|---|
| Alabama | 144 | | |
| Arizona | 22 | 54 | 40 |
| Arkansas | | | |
| California | 453 | 716 | 645 |
| Colorado | 151 | 168 | 140 |
| Connecticut | 96 | | |
| Delaware | 18 | | |
| Florida | | | |
| Georgia | 82 | 109 | 109 |
| Idaho | 63 | 57 | 83 |
| Illinois | 498 | 675 | 646 |
| Indiana | 263 | 268 | 274 |
| Iowa | 113 | 112 | 119 |
| Kansas | 71 | 72 | 84 |
| Kentucky | 120 | 108 | 97 |
| Louisiana | | | |
| Maine | 49 | 64 | 38 |
| Maryland | 116 | 126 | 139 |
| Massachusetts | 296 | 330 | 336 |
| Michigan | | | 276[1] |
| Minnesota | 134 | 204 | 123 |
| Mississippi | | | |
| Missouri | | | |
| Montana | 83 | 81 | 87 |
| Nebraska | 30 | 30 | 35 |
| Nevada | 20 | 31 | 31 |
| New Hampshire | 10[2] | 13 | 19 |
| New Jersey | 282 | 290 | 283 |
| New Mexico | 16[3] | | |
| New York | 1,177 | 1,665 | 1,927 |
| North Carolina | | | |
| North Dakota | 9 | 11 | 13 |
| Ohio | 649 | 803 | 933 |
| Oklahoma | 85 | | |
| Oregon | 138 | | |
| Pennsylvania | 1,924 | 2,112 | 2,209 |
| Rhode Island | 24 | | |
| South Carolina | [3] | | |
| South Dakota | 23 | 18 | 17 |
| Tennessee | 96 | 90 | |
| Texas | 308 | 253 | 299 |
| Utah | 91 | | |
| Vermont | 29 | 35 | 18 |
| Virginia | 133 | | |
| Washington | 287 | 398 | 385 |
| West Virginia | 429 | 501 | 729 |
| Wisconsin | 181 | 168 | 134 |
| Wyoming | 51 | | |

[1] Compensable.
[2] Ten months.
[3] Coal mines only

Figures from Ethelbert Stewart, U. S. Commissioner of Labor Statistics.

by individual states, Kentucky apparently being the only industrial state exhibiting a consistent decrease. To what extent the general increase is real and not attributable to more thorough reporting, and to what extent the rates based on actual exposure have actually increased cannot be said. Commissioner Stewart justly observes:

> The machinery for collection of adequate and reliable reports on industrial accidents in the United States unfortunately does not exist. We are, therefore, perforce thrown back upon the necessity of resorting to estimates, which is, of course, a confession that as a people we do not care enough about industrial deaths and injuries even to count them.

**Metropolitan Life Insurance Experience.**—In Fig. 2 is shown fatality rates from general industrial accidents and industrial

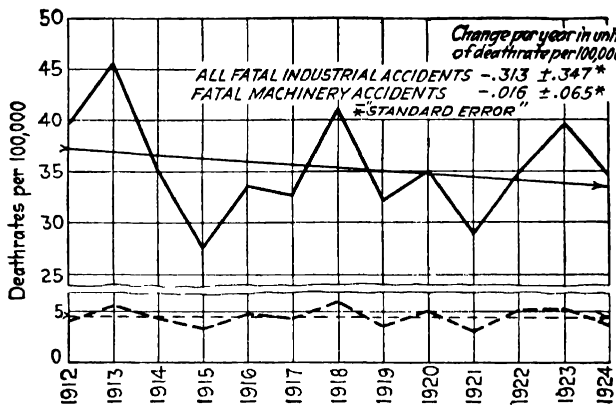


FIG. 2—Fatal industrial accidents and machinery accidents in industry—Metropolitan Life Insurance Company experience.

machinery accidents among policyholders of the Metropolitan Life Insurance Company, white males, 15 years of age and over.[1] The trend of the former curve is generally downward, but it has been pointed out by Dr. Louis I. Dublin, Statistician of the Metropolitan, that, because of the recognized probability of error, this trend may be more apparent than real. That a true reduction has been attained cannot be asserted.,

**Accident Reduction in Industrial Groups.**—The experiences of certain industries or industrial groups show material accident

[1] To be published in the *Statistical Bulletin* of the Metropolitan Life Insurance Company, December, 1925.

reductions attributable to the safety movement which are not definitely reflected in national or state statistics. An illuminating example is the iron and steel industry of which complete accident records are fortunately available through the U. S. Bureau of Labor Statistics. These records and their masterly analysis are largely the work of Dr. Lucian W. Chaney, the leading authority on this subject.[1]

Figure 3 shows clearly the downward trend of frequency and severity rates in this industry, the rates in this case being computed for 5-year periods ending with each year from 1911 to 1924. Table II compares the frequency rate of the entire industry

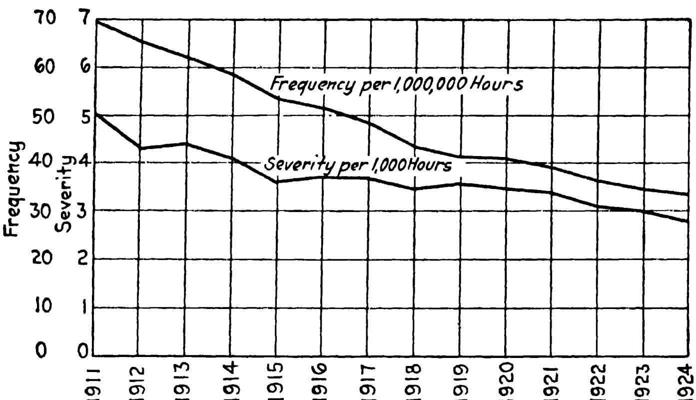


FIG. 3.—Trend in accident rates for five year periods in the iron and steel industry. (*U. S. Bureau of Labor Statistics.*)

with that of a section equivalent to approximately 50% composed of plants selected for their recognized success in accident prevention.

It will be noted that while the industry as a whole showed a 44% decrease in accident frequency during a 14-year period, the selected section experienced a 79% reduction in 11 years. It is also noteworthy that in the year 1923, when the plants of the selected group were enjoying an average accident frequency of only 12.8, the balance of the industry had a frequency approximating 50; in other words, they were probably paying about four times as much for accidents as their business competitors.

[1] "Accident Experience in the Iron and Steel Industry to the End of 1924," *Monthly Labor Rev.*, U. S. Bur. Labor Statistics, **21,** 6, p. 142, 1925; *Bull.* 339, U. S. Bur. Labor Statistics, p. 36, 1923.

TABLE II.—ACCIDENT FREQUENCY RATES PER 1,000,000 HOURS EXPOSURE IN THE IRON AND STEEL INDUSTRY

| Total industry | | Selected section | |
|---|---|---|---|
| Period | Rate | Period | Rate |
| 1910 to 1914 | 59 2 | 1913 | 60.3 |
| | | 1914 | 43 5 |
| 1915 to 1919 | 41.0 | 1915 | 41.5 |
| | | 1916 | 44.4 |
| | | 1917 | 34 5 |
| | | 1918 | 28.8 |
| | | 1919 | 26 3 |
| 1920 | 38 3 | 1920 | 22 0 |
| 1921 | 30 8 | 1921 | 13.3 |
| 1922 | 33 0 | 1922 | 13 0 |
| 1923 | 33 2 | 1923 | 12 8 |
| 1924 | 30 8 | | |

From *Bull.* 339, U S. Bur. Labor Statistics

Substantial reductions in fatality rates have been made in many departments of the steel industry as shown in Table III.

TABLE III.—ACCIDENT FATALITY RATES PER 1,000,000 HOURS EXPOSURE IN SELECTED DEPARTMENTS OF THE STEEL INDUSTRY

| Department | Rate | | | % reduction |
|---|---|---|---|---|
| | 1910 to 1914 | 1912 to 1914 | 1920 to 1924 | |
| Blast furnaces | 0 9 | | 0 6 | 33 |
| Bessemer converters | 0 7 | | 0 3 | 57 |
| Heavy rolling mills. | 0 4 | | 0 2 | 50 |
| Sheet mills. | 0 2 | | 0 1 | 50 |
| Tube mills. | 0 2 | | 0 1 | 50 |
| Fabrication | 0.3 | | 0 2 | 33 |
| Forge shops | 0 4 | | 0 1 | 75 |
| Electrical department. | 0 8 | | 0 4 | 50 |
| Yards. | 0 7 | | 0 4 | 43 |
| Coke ovens | | 0 7 | 0 2 | 72 |
| Axle works. | 0 5 | | 0 2 | 60 |
| Car wheels | | 0 4 | 0 2 | 50 |
| Structural steel erection. | | 4 0 | 2 6 | 35 |

From *Monthly Labor Rev.*, U. S. Bur. of Labor Statistics, **21,** p 6, 1925

So significant have been the reductions witnessed in the iron and steel industry that Chaney, ever cautious in his estimate of the value of accident prevention as practiced, declares:

> Two things may be regarded as proved by the results of the safety movement: (1) Proper education and the development of interest among the men will go a long way in the reduction of minor injury. (2) Adequate engineering revision will reduce serious cases to an, as yet, undetermined degree.[1]

Although mining is regarded as an especially hazardous occupation, marked reduction in the frequency of fatal accidents has been accomplished in spite of the occasional occurrence of disastrous explosions and fires. In coal mining, the publications of the U. S. Bureau of Mines show a fatality rate for the entire industry of 2.06 deaths per million hours worked in 1907 and 1.47 in 1924—a reduction of 28%. This was accompanied by a marked increase in the production per death. Metal mining showed a slightly greater reduction (32%) in a shorter period, the fatality rate being 1.48 in 1911 and 1 in 1923. The rate for the quarrying industry was 0.74 in 1911 and 0.56 in 1923—a reduction of 24%. In the metallurgical industry, while ore dressing and auxiliary works showed no consistent gains, the rate for smelting plants dropped from 0.64 in 1913 to 0.26 in 1923—a decrease of 41%.

Railroading, another hazardous industry and one in which very accurate records are maintained by the Interstate Commerce Commission, has shown some remarkable reductions in fatal and non-fatal accident frequency for certain hazards and in certain classes of employment. In the year ending June 30, 1889, the fatality rate was 2.80 per thousand employed; this has been progressively reduced to the low figure of 0.86 for the year 1924. In the meantime, total casualties from collisions have decreased from 10,317 in 1907 to 1,924 in 1924.

The fatality rate among brakemen in yard service, which was 8.49 (deaths per 1,000 employed) in 1916, had fallen to 4.30 in 1922—49% reduction in 6 years. Over the same period, the rate for brakemen in road freight service decreased from 6.83 to 3.84—43% reduction. Among firemen and their helpers in yard service, the fatality rate was 1.36 in 1916 and only 0.26 in 1922—*81% reduction*. With the same class in road freight service, the fatality

[1] "Causes and Prevention of Accidents in the Iron and Steel Industry," *Bull.* 298, U. S. Bur. Labor Statistics, p. 203, 1922.

rate was 3.18 in 1916 and 1.46 in 1922—54% reduction. Of fatal accidents among railroad employes as a whole, Lew R. Palmer, conservation engineer of the Equitable Life Assurance Society and for long a careful student of the railroad accident situation, states: "Fatalities among railroad employes during the 5-year period, 1918 to 1923, were by far the lowest of any similar period since the year 1898."[1]

**Accident Reduction in Trade Sections of the National Safety Council.**—The National Safety Council is a cooperative service organization organized in 1913 and dedicated to the advancement of accident prevention. Its industrial member companies are divided into trade sections representing manufacturing groups having similar occupational hazards. Since these sections are composed of industrial firms particularly interested and presumably active in safety work, we should expect their sectional accident statistics to show marked reductions. They do so in some instances, but a disturbing element is introduced by the incompleteness of the reports of earlier years during which some of the members of the sections failed to turn in figures on their accident experience. Since these were probably companies which were at the time making poor records, the sectional figures for successive years are not usually quite comparable and conclusions drawn from them are not above criticism. Some of these are quoted, however, for what they are worth, although they usually cover but two years.

Records of the entire Automotive Section are available for 1922 to 1924 but cannot be used as a whole for the reasons given above. In the Automobile Parts Manufacturing Division, however, we may compare the 1923 and 1924 records of 29 companies or plants employing about 22,000 men. The frequency rate for this group declined from 54.8 to 27.9 and the severity rate from 1.81 to 1.13, decreases of 50 and 36%, respectively.

In the Wire and Wire Products Division of the Metals Section, 14 plants employing 6,325 persons contributed a frequency rate of 40.3 in 1923 and 34.3 in 1924, with severity rates of 3.30 and 1.90, respectively, representing decreases of 15 and 41%.

The records of the entire Paper and Pulp Section for 1923 and 1924 are fairly comparable and include 62 companies or plants employing about 37,000. The frequency rates for these years

[1] "The National Cost of Railroad Accidents," *Proc. Nat. Safety Council*, Twelfth Annual Safety Congress, p. 1073, 1923.

were 43.5 and 41.6, respectively, and the severity rates 2.73 and 2.01, indicating reductions of 4 and 26%.

The statistics of the Rubber Section of the Council are issued in a somewhat different form from that of other sections and, as such, are more difficult to analyze. It appears, however, that accident frequency has gradually decreased from 37.6 in the second half of 1921 to 23.2 in the second half of 1924. Severity rates during this period were more erratic, reaching a maximum of 1.50 in the first half of 1923 but dropping to a minimum of 0.87 in the last half of 1924. These reductions amount to 38 and 42%, respectively. The section represents about 64,000 employes.

In the Woodworking Section we may compare the 1923 and 1924 records of three divisions: Furniture Manufacturing, with 11 companies or plants and 2,000 employes; Agricultural Implement Manufacturing, with 5 companies and 1,500 employes; Miscellaneous Manufacturing Companies having large woodworking departments, with 8 companies and 2,500 employes. The first division reduced its frequency rate from 21.3 to 19.4 and its severity rate from 0.53 to 0.46; the second reduced frequency from 65.9 to 32.2 and severity from 3.30 to 0.39—both very significant reductions; the third division reduced frequency from 30.3 to 26.7 and severity from 4.64 to 1.45.

Some of the sections have statistics compiled as early as 1920 but they are largely incomplete due to the reluctance of many of their members to make public their accident records or even compile them on a standard basis. The future will undoubtedly witness the compilation of better records by those interested in accident prevention. From what the National Safety Council has available at the present time, however, the following deductions may be drawn: (1) The trend of the sectional frequency and severity rates is generally downward. (2) Such reductions as have been made were secured during years when the general accident mortality rate of the country was increasing. (3) There are no apparent increases in sectional frequency rates that are not explainable by additions to the sectional total of individually inferior records or by the stimulus to reporting accidents which is invariably encountered in the early stages of preventive work and which leads always to an apparent, though unreal, increase infrequency. Notwithstanding these favorable deductions, it must be admitted that the sectional records, taken as a whole, do not as yet contain convincing evidence of the general success of the safety movement.

**Conclusions.**—Industrial accidents in the United States are probably increasing in number, but there are no reliable data on which to base the conclusion that industrial accident *rates* based on working exposure are actually increasing. The author is of the opinion that the latter are not increasing but actually falling slightly, but this is, of course, mere conjecture.

Three large and important industrial groups—the iron and steel industry, the mines and the railroads—show consistent rate reductions. In these groups can be discerned the dominant influence of four types of leadership:

1. Leadership of outstanding men.
2. Leadership of progressive corporations.
3. Federal leadership.
4. Leadership of industrial organizations.

In the iron and steel industry the influence of Judge Gary and the United States Steel Corporation, of Dr. Lucian W. Chaney and the U. S. Bureau of Labor Statistics, of the Association of Iron and Steel Electrical Engineers and its offspring, the National Safety Council, is incontestable.

In the mining field we see also the presence of prominent industrial leaders and progressive companies, some of them under the same corporate control as progressive companies in the iron and steel industry. In the background stands the U. S. Bureau of Mines, the figure of the late Dr. Joseph A. Holmes, and the Mines Safety Association, which later became the Mining Section of the National Safety Council.

In the railroad field the outstanding men and progressive roads are too numerous to mention. There is likewise a federal and national background formed by the Interstate Commerce Commission, the American Railway Association with its Safety Section, and the National Safety Council with its Railroad Section, all three actively functioning to reduce accidents and credited with no small share of what has been accomplished.

We see, therefore, that in these three great industrial fields powerful influences have been at work during the past two decades striving to bring about a lessening of industrial accidents. Indeed, these fields were the battlegrounds of the pioneers in accident prevention and victories should have been won here if anywhere.

The value of leadership in accident prevention work will be more fully discussed in subsequent chapters.

## CHAPTER II

## WHAT INDUSTRIAL SAFETY ACCOMPLISHES—CORPORATION AND PLANT EXPERIENCE

It is in the experience of individual companies and plants, and especially in the experience of the larger and more progressive corporations, that we must expect to find the most striking instances of accident reduction. The national safety movement, though born 15 years ago, is yet too young to have left a deep imprint on the records of American industry as a whole or even on those of its major subdivisions. Safety is primarily an educational movement and as such may be expected to make progress slowly and somewhat unevenly. Indeed, the progress it has made up to this time is remarkable if one considers the obstacles that must be overcome before the acceptance of new concepts of the value of human life can be secured.

**Accomplishments of the United States Steel Corporation.**—The accident experience of the iron and steel industry has been already cited and we may now examine the experience of the United States Steel Corporation, the recognized pioneer in accident prevention.

Systematic safety work, undertaken previously by some of its subsidiary companies, became a corporation activity in 1906. Its record is one to which it may point with justifiable pride and one which gives weight to the statement of Judge Elbert H. Gary that "accident prevention is not only good morals and good ethics, but also good business." Reckoned on the basis of frequency of accidents involving death, permanent disability or temporary disability of over 35 days, the records of the corporation indicate that 35,596 employes were saved from serious injury in the period 1912 to 1923, inclusive.

For accident prevention, $9,763,063 was expended between Jan. 1, 1912, and Sept. 30, 1922, resulting in an estimated saving of $14,609,920—a return of 50% on the investment. In addition to this, there were further savings from increased production,

improved quality, decreased overhead and lower labor turnover. The amount of these cannot be estimated, but the point is made when it is shown that one of the greatest of American industrial corporations and one of the first to take up accident prevention has proved its efforts well justified by the direct savings obtained. Since 1923 its good work has continued. Comparing 1925 records with those of 1906, serious and fatal accidents have been reduced 61.0%. Since 1912 "disabling accidents" (tabulatable cases) have been reduced 78.7%.

The courtesy of Charles L. Close, Manager of the Bureau of Safety, Sanitation, Welfare and Relief of the United States Steel Corporation, enables us to produce in Table IV some truly remarkable records of long no-accident periods on individual plants.

TABLE IV.—CONSPICUOUS NO-ACCIDENT RECORDS OF WORKS OF THE UNITED STATES STEEL CORPORATION

| Company | Works | Department | Number of employes | No-accident period[1] | Approximate man-days |
|---|---|---|---|---|---|
| Carnegie Steel | Farrell | all | 2,900 | 95 days | 275,500 |
| | New Castle | all | 2,200 | 86 days | 189,200 |
| | Edgar Thomson | all | 6,000 | 69 days | 414,000 |
| | Duquesne | blast furnace | 281 | year 1924 | 84,300 |
| National Tube | Ellwood City | cold draw | 300 | 4 years, 3 days | 360,900 |
| | | hot mill | 428 | 362 days | 154,936 |
| | | hot mill | 529 | 392 days | 207,368 |
| | Gary | all | 1,022 | 129 days | 131,800 |
| | Ellwood | all | 2,300 | 2 months, 15 days | 149,500 |
| Illinois Steel | Consolidated | all | 820 | 542 days | 444,400 |
| | New Haven[2] | all | 575 | 166 days | |
| | | | | 107 days | |
| | | | | 123 days | |
| | | | | 104 days | |
| | | | | 235 days | 135,100 |
| American Bridge | Pencoyd | machine shop | 109 | 8 months | 21,800 |
| | Elmira | all | 139 | 7 months | 24,300 |

[1] Calendar days, months or years.

[2] Records made by this plant cover period Nov 13, 1920 to July 16, 1923, with intermission of only a few days.

**Accident Reductions in Other Large Corporations.**—The frequency of injury among employes of the manufacturing department of the Standard Oil Company of New Jersey in 1921 was 6.84 per 1,000 employed and 2.84 in 1924—a reduction of 58%. During the same period the severity in days lost

(weighted) per employe per year was reduced from 7.28 to 3.09 and the average accrued liability on account of injuries from $9.34 to $4.40 per employe. Among the plants of this company and those of the Standard Oil Company of Louisiana the following no-accident records have been made:

| Works | Average number of employes | Calendar days | Equivalent working hours exposure |
|---|---|---|---|
| Camden. | 252 | 626 | 1,066,328 |
| Baton Rouge | 3,671 | 45 | 1,083,680 |
| Baltimore | 1,173 | 174 | 1,379,496 |
| Eagle | 1,225 | 188 | 1,550,680 |

In the International Harvester Company organized safety work was undertaken in 1908 and by 1922 the frequency of lost-time accidents had been reduced 76%. The frequency rate for 1923 was 29.7 per million hours worked, which was reduced in 1924 to 24.3. The 1923 severity rate of 3.04 days (weighted) per thousand hours worked was reduced to 2.52 in 1924, in spite of increased activities requiring the employment of much new labor. Several conspicuous records have been made by individual plants. The Chatham Works with 150 employes had, at the time of writing, completed over 24 consecutive months without a lost-time injury, while one of the twine mills with 450 male and female employes had completed 9½ months. A small machine shop employing 28 men had made a no-accident record of 1,594 calendar days.

The Clark Thread Company of Newark, N. J., with between 4,800 and 5,000 employes, has achieved the remarkable no-accident record of 268 calendar days—approximately ten million man-hours! The consistency with which this company has been able to decrease its frequency and severity rates, under effective safety organization, is manifest in the following tabulation:

| | 1921 | 1922 | 1923 | 1924 | 1925 (8 months) |
|---|---|---|---|---|---|
| Frequency rate | 18 3 | 12 6 | 3 01 | 1 79 | 0 43 |
| Severity rate | 2.08 | 1 50 | 0 68 | 0 16 | 0 02 |

The sum of $8,012.40 was paid out in compensation for injuries incurred in 1921; the corresponding figure for 1924 was $2,278.92. In the first 8 months of 1925 over 4,000 hours were saved!

W. C. Dickerman, Vice-president of the American Car and Foundry Company, is authority for the statement that by the expenditure of approximately one million dollars in 14 years for accident prevention a saving has been made by his company of approximately $2,700,000 in liability and compensation payments. Mr. Dickerman says:

> Safety pays large dividends, to which may be added the reduced costs resulting from increased production and improved quality, decreased overhead and decreased labor turnover. These savings cannot be reduced so readily to dollars and cents; nevertheless they exist and in themselves present a vigorous and emphatic argument for the spread of the safety movement.[1]

The Union Pacific Railroad Company has reduced its total casualties (fatalities and injuries resulting in 3 or more days' loss of time) per 100 employes from 8.13 in 1914 to 0.84 in 1924—a record not surpassed by any major railroad in the United States.

The American Smelting and Refining Company reduced its accident frequency 76% between the years 1913 and 1921 with an estimated prevention of 9,692 accidents and a saving to its liability fund of $1,380,982. This was equivalent to a dividend of 46.4% on the $602,124 invested during this period in accident prevention.

The Bethlehem Steel Corporation employs between 60,000 and 70,000 operatives in its mills, shipyards and mines. The number of accidents is today one-half what it was when safety work was started 8 years ago.[2] The fatality rate of the corporation has been reduced 25% and its frequency rate 40%. The present fatality rates of its steel mills, mines and shipyards are, respectively, 12, 12 and 71% below the average of the entire industry in the United States. Its Lackawanna Bridge Works with 250 men ran 14 months (726,500 man-hours) producing over 27,000 tons of structural material without an accident.

E. G. Grace, President of the Corporation, states:

> Accident prevention work pays three-fold returns. There is a return to the employer in lower costs, a return to the employe in a physical

[1] "The Broader Economics of Safety," *National Safety News*, Chicago; National Safety Council, **13, 1,** p. 7, 1926.

[2] CULLINEY, J. E., "Accident Prevention Progress in the Steel Industry," *Labor and Industry*, Pa. Dept. Labor and Industry, **12, 7,** p. 3, 1925.

and monetary saving, and a return to the community through a lessening of care for the maimed and disabled. Any one of these alone justifies the furtherance of the work, but taken in the aggregate they constitute one of the most important planks in the platform of good business.[1]

Comparing the records of 1925 with those of 1920, 99 plants of members of the Portland Cement Association reduced their aggregate fatalities 33%, all accidents 45% and days lost 40%—a very remarkable record for such a large and diverse group. During a special no-accident month in June, 1925, 72 of the 125 separate plants of the association had no lost-time accidents. The net reductions obtained were as follows:[2]

| | In accidents, % | In days lost, % |
|---|---|---|
| Compared with June, 1924 | 66 | 65 |
| Compared with 12 months, 1924 | 73 | 76 |

The Lehigh Portland Cement Company with 15 plants has consistently reduced the number of days lost from work on account of accidents per 100,000 man-hours from 59.2 in 1919 to 18.8 in 1924, a reduction of 68%.[3]

The U. S. Navy Department has given serious attention to accident prevention at navy yards and naval stations since 1917. It has now a centralized organization with a safety engineer attached to the office of the Assistant Secretary of the Navy at Washington. The frequency rate of compensable accidents has been reduced from 21.8 (per million hours exposure) in 1922 to 18.6 in 1923 accompanied by an estimated saving of $207,433.[4]

The Buick Motor Company from 1918 to 1923 by safety work saved 2,651 employes from serious injury, $151,240 in compensation costs and $132,550 in labor turnover, not to mention "the gain through uninterrupted production, the gain through increase of production by the use of safety devices and the intangible but

[1] *Bethlehem Review*, Bethlehem Steel Corporation, June 25, 1924.

[2] JACOBSEN, H. G., "June No-accident Campaign," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, **1**, p. 241, 1925.

[3] RENINGER, HENRY A., "Safety in the Cement Industry in the Lehigh Valley," *Labor and Industry*, Pa. Dept. Labor and Industry, **12**, 7, p. 16, 1925.

[4] OWEN, STEWART J., "Uncle Sam's Safety Record at the Navy Yards," *Nat. Safety News*, p. 33, Oct. 24, 1924.

vital strengthening of the plant morale through the elimination of these accidents."[1] It is estimated that the saving to its employes amounted to $400,000. Between the years 1920 and 1921 accident frequency was reduced 22%, severity 64%, compensation cost 25%; the number of fatal accidents decreased from 8 to 0, eyes lost from 12 to 5, and dismemberments from 36 to 10.[2]

The Eastman Kodak Company, another firm which has been active in accident prevention, in addition to decreasing its injury frequency rate 30%, lowered injury costs from $55 per 1,000 employes in 1913 to $26.85 in 1924.

The Kimberly-Clark Company, one of the largest manufacturers of paper, has achieved some notable records. Its Niagara Mill with 650 employes had 5 accidents during 1923 but in 1924 ran 150 consecutive working days without accident. This was followed by a record of 162 days which was unbroken at the time of writing. The maintenance and construction department of this mill with 80 employes had an unbroken record of 1,379 working days—over 4 years. The Kimberly Mill with 900 employes had 7 accidents during 1924 but at the time of writing had had an unbroken record of 143 consecutive working days. The compensation costs of the company were reduced from $1.66 in 1917 to $0.66 in 1923.

In 1918 the Delaware and Hudson Company had in its car shops 62.4 casualties per million man-hours worked. It completed its safety organization in 1919 and decreased the rate to 30.2. This was followed by 18.2 in 1920 and 11.0 in 1921. Some of its departments and shops have made remarkable no-accident records, as for example:

| | Man-hours |
|---|---|
| Susquehanna Division Car Department (Oneonta Shops) | 938,461 |
| Pennsylvania Division Car Department (Carbondale Shops) | 503,055 |
| Colonie Car Shops | 1,350,000 |
| Saratoga Division Motive Power Department (Colonie Round House) | 410,267 |
| Colonie Locomotive Shop | 783,471 |

[1] Thalner, R. F., "Value of Accident Statistics on the Standard Basis," *Proc. Nat. Safety Council,* Twelfth Annual Safety Congress, p. 188, 1923.

[2] Boswell, Forrest W., "Supervision and Its Relation to Accident Prevention," *Proc. Nat. Safety Council,* Eleventh Annual Safety Congress, p. 177, 1922.

Another remarkable railroad shop record was made in 1925 by the Pocatello Shops of the Oregon Short Line Railroad Company; 240 days without a reportable accident or 1,880,978 man-hours.

In the Fisk Tire Company the reduction in lost time on account of injury has amounted to 86.3% between 1917 and 1924. It is estimated that 5,178 men have been saved from injury, \$399,523 in wages has been saved the workers, and the company has saved \$110,250 through voluntary reduction in insurance premiums.

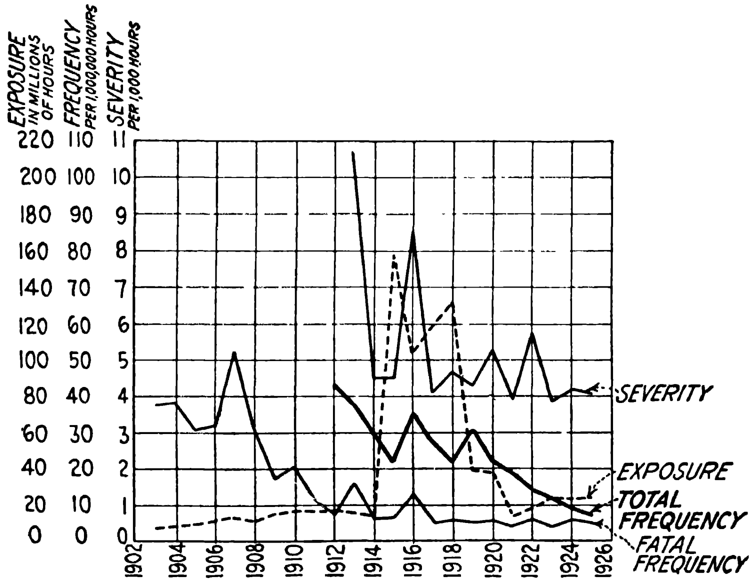


FIG. 4.—Injury rates E. I duPont de Nemours and Company.

The 1924 severity rate of Henry Disston and Sons showed a reduction of 75% below the figure for 1916. In 9 years the company has saved \$75,000 on insurance premiums.

The United States Gysum Company, operating 25 plants, obtained in lost time from injury 25% reduction in 1923, 46% in 1924 and 61% in the first 8 months of 1925, all as compared with the year 1922.

**E. I. duPont de Nemours and Company Records.**[1]—Figure 4 shows the fatality, frequency and severity rates for the duPont

[1] The author may, perhaps, be excused for dwelling at length, here and elsewhere, on the experience of this company with which his own service has made him particularly familiar.

Company. Taking as base the earliest year of record, fatality frequency has been reduced 87%, injury frequency 77%, and severity 67%. During the years 1915 to 1918, due to war activities, the number of employes was increased to approximately ten times the normal without seriously affecting the rates, save only in the year 1916.

In Table V are given some conspicuous no-accident records achieved by duPont plants. The records of its Fuze Works are

TABLE V.—CONSPICUOUS NO-ACCIDENT RECORDS OF WORKS OF E. I. DUPONT DE NEMOURS AND COMPANY

| Works | Manufacture | Number of employes[1] | No-accident period[2] | Approximate man-days |
|---|---|---|---|---|
| Fuze Works | electric blasting caps | 270 | 758 | 204,700 |
| | | 265 | 1,439 | 381,300 |
| Barksdale Works | high explosives | 200 | 717 | 143,400 |
| Norwich Works | paper | 30 | 1,047 | 31,400 |
| Augusta Works | black powder | 18 | 1,279 | 23,000 |
| Connable Works | black powder | 25 | 1,085 | 27,100 |
| Newhall Works | wood pulp | 50 | 1,058 | 52,900 |
| Technical Laboratory | | 110 | 1,275 | 140,200 |
| Brandywine Laboratory | | 30 | 1,191 | 35,700 |
| Newark Works | pigments | 330 | 724 | 238,900 |
| Rushdale Works | black powder | 26 | 947 | 24,600 |
| Everett Works | paints and varnish | 50 | 1,021 | 51,000 |
| Arlington Works | pyralin | 1,340 | 144 | 200,000 |
| | | 1,300 | 194 | 252,200 |
| Repauno Works | high explosives | 706 | 300[3] | 211,800[3] |
| Dye Works | dyes | 1,422 | 170[3] | 241,740[3] |

[1] 2,400 hour per year basis
[2] Consecutive working days
[3] Record unbroken at time of writing

particularly striking inasmuch as they are practically continuous for an aggregate period of *7 years during which there occurred but a single time-losing accident costing* $18.

The record of Barksdale Works was accomplished in spite of the fact that it had previously had as many as 48 injuries in a single year and was forced, during a period of several months, to increase its regular force 50% by the addition of construction

gangs. No injury occurred as result of construction work, however, and its record was finally broken by an unexpected sulphur dust explosion.

The two records of the Arlington Works, interrupted by a period of only 16 calendar days, are also noteworthy because they were made immediately following a year in which 21 accidents were recorded. The long records of the small black powder plants are also interesting, since the inherent hazard of a sensitive explosive is involved and close supervision is difficult, the men being for the most part dispersed in widely separated buildings.

The average cost of injuries (compensation, medical and hospital expenses, excluding main office overhead) to the duPont Company is now in the neighborhood of $1 per $100 of payroll, an exceedingly low figure considering the nature of its operations and the fact that it grants medical and compensation benefits considerably in excess of statutory requirements. What actual saving this low injury cost represents cannot be definitely determined, but for the year 1920 it was estimated that after paying for injuries and for all preventive work there remained a sum equivalent to a dividend of 64% on the amount expended for safety.

Not the least interesting part of the experience of the duPont Company and of its subsidiary, the duPont Engineering Company, has been in the construction field. During the war, an $80,000,000 smokeless powder plant was constructed for the U. S. Government under unusual conditions of pressure for completion. The magnitude of the undertaking may be conjectured from the statement that over 3,500 safety guards for moving machinery were required for the completed plant. About 25,000 men were employed, labor was poor in quality and the turnover high. When the construction safety department was organized, the average lost time per man per year from injury was 2.27 days. In 7 months this was progressively reduced to 0.22 days—a 90% reduction. The final injury costs (including one-half the expense of the operation of a fully equipped and well-staffed plant hospital) amounted to only $0.64 per $100 of payroll.

Other war-time construction jobs, notwithstanding pressure for early completion, exhibited some excellent records and costs as low as $0.13 per $100 of payroll. In more recent years, a brick high school, a city hospital and a large marine terminal

were constructed with injury costs of $0.31, $0.30 and $0.32, respectively. In the field of operating plant construction the experience at the Dye Works of a force of 643 payroll men with 67% labor turnover is worth mentioning. They elected to attain a record of "Ninety Days or Bust." Twice a "bust" occurred when the 90 days was almost in sight, but the third attempt was successful. In the entire period of 305 days there were only 5 trivial accidents with an aggregate cost of $6!

**Miscellaneous Records and Reductions.**—New no-accident records are constantly being reported in the *National Safety News*.[1] A few picked at random from this source are as follows:

H. H. Robertson Co., Pittsburgh—285,000 man-hours.

M. J. Whittall Associates, Worcester, Mass.—rugs and carpets—1,500 employes—5 months.

American Steel and Wire Co., Donora, Pa.—350,000 man-hours.

M. T. Stevens and Sons Co., Osgood Mills—textiles—151 employes—1 year.

C. P. Darling Co. (United States Finishing Co.)—512 employes—9 months.

Haverhill Electric Co.—584 employes—6 months.

Kohler Industries:

Auto Piano Co.—645 employes—7 months.

Auto Pneumatic Action Co.—947 employes—1 year.

Hazleton Bros.—933 employes—11 months.

Milton Piano Co.—1,223 employes—1 year.

American Rolling Mill Co., Ashland Plant, Blast Furnace Dept.—142 employes—8 months.

New York Telephone Co., New Jersey Division plant force—2,513 employes—106 days.

Illinois Bell Telephone Co.—1,300 employes—1 month.

Wickwire Spencer Steel Corp., Buffalo Plant—1,100 employes—two records of 1 month.

Tuscon Steel Co., Youngstown, Ohio—5,000 employes—no fatal accidents for 20 years.

One must not think that long no-accident records and conspicuous reductions in injury frequency or severity are merely the result of good fortune. In but few instances are they easily obtained. Usually they are the reward of years of conscious, patient effort. The following story of a cement plant is typical:

[1] Published monthly for its members by National Safety Council, 108 East Ohio St., Chicago, Ill.

I recently visited a plant which, up to 1921, had never had a single month without an accident. In 1921 they started a no-accident month campaign. They didn't have very good faith in it, but they organized under the direction and assistance of Mr. Jacobsen, and appointed the committees and departmental teams. They failed. They tried again, however, because they had made some progress, and before the year was out they had to their credit 1 month without an accident. They thought that a wonderful achievement, and they kept at it with enthusiasm. The next year, instead of 1 month, they got 5 months without an accident. And last year, in 1924, that same plant had 9 no-accident months. Now they are out for a no-accident year. Their slogan is "No Accidents in 1925" and they believe they are going to get it. There aren't any skeptics among them. Those who were skeptics are now convinced.[1]

Good results have, in most cases, been but the last step in a series of advances. Numerous examples might be cited. For instance, the machine shop department of the Elk Tanning Co., Ridgway Pa., with 65 employes, lost 60 days in 1922 on account of accidents, in 1923 5 days, but by January 1925, had gone 19 consecutive months without any lost time from injury. In 1918 in the operation of its properties, injuries and damages cost the East St. Louis Railway Co. 4.04% of its gross passenger revenue. This was reduced to 3.63% in 1919, 3.31% in 1920, 2.75% in 1921 and 2.29% in 1922. The Hydraulic Pressed Brick Co. of St. Louis had accident costs of 18.3 cents per thousand bricks in 1920 which were reduced to 16.4 cents in 1921, 12.7 cents in 1922 and 6.9 cents in 1923.

No. 8 Plant of the Canada Cement Co., Ltd. of Port Colborne, Ont. reported the worst record among plants of its company and closed 1921 with 67 lost-time accidents. It reorganized its safety work and was rewarded with 67 days clear record, followed by other records of 40, 147 and 89 days. In 1924 there were but 9 accidents and when last reported it had completed a 6-months no-accident period.

James Stewart and Co., one of the largest contracting firms, as result of safety work, received 36% credits on liability insurance rates in 1921, 53% in 1922 and 64% in 1924. The value of the latter credit was equivalent to $2.80 on each $100 of payroll.

[1] TAGGE, A. C., Address before Annual Eastern Cement District Safety Meeting, *Accident Prevention Bull. of Portland Cement Association*, **11, 3,** p. 4, 1925.

PLATE IIIa.—Safety Committee Meeting—American Radiator Company. (*National Safety Council.*)

PLATE IIIb.—Shop Safety Rally. (*National Safety Council.*)

(*Facing page 28*)

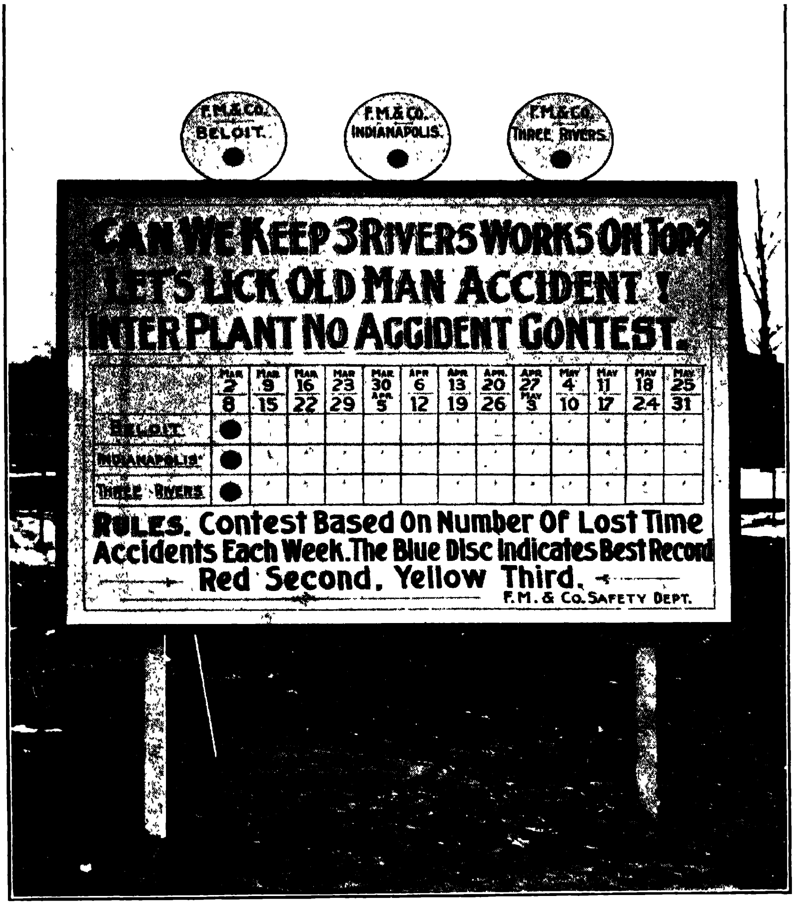


PLATE IV.—Accident Score Board—Fairbanks Morse and Company. (*National Safety Council.*)

(*Facing page 29*)

A series of typical reductions in accident costs reported by the National Safety Council as obtained by members is given in Table VI.

TABLE VI.—TYPICAL REDUCTIONS IN ACCIDENT COSTS AMONG NATIONAL SAFETY COUNCIL MEMBERS

| Company | Year | Costs per $100 of payroll | Reduction, per cent |
|---|---|---|---|
| Edward Hines Yellow Pine Trustees | 1922<br>1923 | 4.18<br>1 62 | 61 2 |
| Hoopes and Townsend Co | 1921<br>1922 | 0 88<br>0.33 | 62.5 |
| Willard Storage Battery Co | 1918<br>1923 | 0 99<br>0.35 | 64 7 |
| Sperry Gyroscope Co | 1917<br>1923 | 2.12<br>0.59 | 72.2 |
| Colorado Power Co. | 1920<br>1923 | 1.10<br>0.27 | 75.4 |
| Nekoosa-Edwards Paper Co | 1922<br>1923 | 0 51<br>0.26 | 49 1 |
| Union Traction Co. of Indiana | 1912<br>1923 | 2 65<br>1 00 | 62.2 |
| Texas Power and Light Co. | 1920<br>1923 | 3 60<br>0 81 | 77.5 |
| Oliver Chilled Plow Works | 1922<br>1923 | 0 67<br>0.24 | 64 2 |
| Carpenter Steel Co | 1921<br>1923 | 2 53<br>1 04 | 58 8 |
| Northern Indiana Gas and Electric Co. (Southern Division) | 1922<br>1923 | 2 59<br>0.53 | 79.7 |

These reductions are not comparable since the natural hazards of the industries represented, prevailing wage rates and existing compensation schedules differ, but individually each expresses a direct saving secured through accident prevention efforts. Many other cases might be quoted. The Philadelphia Plant of the Pennsylvania Salt Manufacturing Company, for example, reduced its accident costs from $4,591.27 in 1923 to $2,196.91 in 1924, while the Wyandotte Plant of the same company reduced accident costs from $3,485.13 to $766.48. The Kelly Springfield Tire Company reduced accident costs from $14,736.47 in 1923 to $7,267.68 in 1924. Reductions of 50% in accident costs in-

1 year are not uncommon and examples may be found in almost every industry.

Other substantial, though less tangible, gains follow in the train of successful safety work. While these will be the subject of discussion in subsequent chapters, it is timely to quote here some observations by one of the closest and most capable observers of progress in accident prevention, W. H. Cameron, Managing Director of the National Safety Council:

> The benefits accruing from accident prevention work among employes are manifold. To the companies involved, the movement has meant the saving of millions of dollars and thousands of lives. To the workman it has meant the prevention of a tragedy and the possibility of pursuing his work with the knowledge that he is safe from injury and in pleasant surroundings.
>
> Safety work in one automobile plant in 1 year saved time enough to build 30 additional trucks. In another case, the public record of the money saved by safety work on one railroad was translated into the striking statement that the saving represented the gross passenger revenue from 82 16-section Pullman cars full of passengers operated for 1,000 miles.
>
> Nineteen thousand milk cans are estimated as the equivalent of the annual saving through the reduction of lost-time accidents in a Milwaukee plant. The saving of a large paper company in 1 year represents a finished strip of paper 6 feet wide and over 50,000 miles long—enough to encircle the globe twice.[1]

**Conclusions.**—There is overwhelming evidence of the success of accident prevention efforts in hundreds of scattered and diverse industrial establishments. Their experience has proved beyond question that in both large and small plants safety work can be made to pay for itself in actual savings. As industrial accident prevention spreads, matures and sloughs off certain of its exuberances, as it passes out of the "movement" stage and becomes an admitted requisite of efficient industrial management, its true value will be indicated by consistent reductions in the statistics of the larger groups, industrial, state and national. That such reductions have not yet manifested themselves clearly is no discredit to a movement the success of which depends so largely on educational effort.

No industrial executive, however, has justification for delaying the adoption of an accident prevention policy pending a more

[1] GILFILLAN, R. S., "Plug Up That $5,000,000,000 Leak," *Trained Men*, International Correspondence Schools, **5**, 5, p. 91, 1925.

universal demonstration of the success of the safety movement. Sufficient evidence of its success is already at hand. Further delay in organizing and prosecuting the work intelligently and systematically will only lead to additional accident expenses and the loss of the many indirect advantages that accrue from safety work. Furthermore, an executive who fails to take his appropriate place in a movement that has been generally accepted and bids fair to become universal retards industrial progress and permits the continuance of an inconceivable amount of human suffering that he might be instrumental in obviating.

# CHAPTER III

## FUNDAMENTAL REQUIREMENTS

In the preceding chapter were enumerated many examples of successful accident prevention effort, but from this it should not be assumed that throughout industry safety work has been attended by unqualified success. Such is not the case and many industrial establishments have made but little, or erratic, progress. In frequent instances, considerable sums of money have been expended year after year without commensurate return and, although this has not often led to actually abandoning the effort, it has been an obvious source of discouragement. While this might eventually influence some business executives to give up their accident prevention efforts, such discontinuance would in most cases be temporary only. There is every reason for the belief that the safety movement is firmly entrenched in the industrial life of the country, from which position it will inevitably continue to advance until it has become an integral part of accepted management practice.

**Need for Technique.**—The responsibility for past failure to effect adequate accident reduction does not lie entirely with industry or with industrial executives; it is largely due, in the author's opinion, to the absence of an appropriate technique of accident prevention based on sound principles.

The safety movement had its origin in the changed conditions which arose from the enactment of workmen's compensation laws, replacing "the long-time conception of individual responsibility, fossilized in employers' liability legislation obviously enacted chiefly for the protection of the employer."[1] Developing sporadically, and in the beginning somewhat as a measure of self-protection on the part of the employer, it produced a welter of unrelated, often ill-conceived and frequently spectacular efforts to enlist and hold the attention of rank-and-file employes.

[1] Hoffman, Frederick L., "Progress in Industrial Accident Prevention," *Safety Engineering*, **49**, p. 164, 1925.

Attracted by these displays or urged on by increasing accident costs, other employers entered the safety field and borrowed freely from their neighbors or originated new "stunts" of their own. However valuable this may have been in promoting acceptance of the slogan "Safety First," it resulted eventually in a chaotic condition from which dependable lessons of experience have only recently commenced to emerge—lessons upon which a technique of accident prevention could be reasonably established.

Fifteen years ago accident prevention was new and the few industrial concerns which had interested themselves in it were pioneers. While there is still much unexplored territory and many new lessons to be learned (among them perhaps the greatest and most unexpected truths), the industrial executive or engineer who takes up the work today need not make the mistakes that were common errors a few years ago. True, there is no royal road to accident elimination but each year as the movement gains momentum progress is made easier for all. The fund of available information is constantly growing. Life saving is a field of endeavor in which self-seeking does not flourish and in its absence all excuse for withholding information is gone. The results of experience, some of them very dearly bought, may be had literally for the asking and the newcomer in the field would be shortsighted indeed if he did not avail himself of them, and worse than shortsighted, perhaps, since lives of others would be needlessly sacrificed.

We therefore say to the reader, if a newcomer or an early beginner, by all means realize that in the general phases of the work, especially stimulative work, there is practically nothing new and that all "new schemes" are usually but variants of what has been tried many times before. Instead of spending time and money on them in the first flush of enthusiasm, learn first where they have been tried already and with what success; also determine whether they can be successfully transplanted. Above all, stick hard to the fundamental requirements without which no schemes or "stunts," however captivating they appear at first, can be made effective.

**Basic Concepts.**—Before setting forth what the author believes to be some of the fundamental requirements for successful accident prevention work it is necessary to state clearly the mental concepts upon which they rest. They are the following:

**1.** Industrial accidents are destructive, disturbing and wasteful.

**2.** Their prevention is morally, ethically and economically justified.

**3.** Prevention may be sought through

*a.* protection,

*b.* instruction,

*c.* removal or reduction of the hazard; but the success of any or all of these methods is conditioned on *safety education.*

**4.** Safety education is primarily the teaching of new concepts of the value of human life and of accident *preventivity*, and the application of these concepts to industrial conduct.

**5.** Virtual accident elimination is approached only

*a.* When the new concepts have infiltrated the minds of all units in the industrial establishment and have become a guiding force educing fixed habits of *safe* thought and action;

*b.* when all units have united to overcome by mass effort the ascendancy of unsafe methods, procedure and conditions of work.

**6.** Organization is the effective medium for the education of the individual adult and for mobilizing the industrial establishment in mass effort.

**7.** The primary function of safety organization is to educate, stimulate and develop, but the practical application of safety must be along functional lines, that is, through the normal operating organization.

Under these concepts the safety organization becomes essentially a school for adults, training them for one phase of industrial life and at the same time mobilizing them for concerted action against a serious condition of mental and material maladjustment. If this condition did not exist, if a tremendous educational assault were not called for, an organization essentially separate and distinct from the operating structure of the plant would be unjustifiable. The need, however, is present and the situation is beyond the ability of the normal organization to cope with successfully. A special organization is therefore justified. Whether it will be a permanent part of the future industrial picture, only time can tell.

The foregoing basic concepts will be detected underlying the greater part of the recommendations and suggestions contained in this volume. The fundamental requirements, which follow, are conditioned upon their acceptance, as are also the principles of organization which are set down later. Many of these principles, be it said, are far from new. Some of them will be found in the earliest publication on the subject, "How to Organize for Safety," by R. W. Campbell, issued in 1912 by the National Safety Council. They have therefore withstood the acid test of time.

**The Employer's Attitude.**—First and most indispensable to success in accident prevention is the requirement that the industrial executive must actually *want* to make his establishment safe. He has, indeed, both a legal and moral obligation to do so. Hoffman states:

> I have always been strongly opposed to the viewpoint which holds the worker primarily responsible for accident occurrences. The worker has other things to think about than his personal safety, comfort and welfare. To the extent that industry becomes more exacting and the driving force for results increases, the accident liability correspondingly increases, and likewise the duty of the employer to leave nothing undone to effectively safeguard the worker.[1]

The desire on the part of the employer must, however, go far beyond mere perfunctory compliance with accepted obligations. It must be a set purpose to accomplish a desired end.

> The organization, from the president down, that realizes the value of safety and backs up the safety department and plant superintendents, *can expect results.* However, where indifference is manifested by those in authority, *no results can be expected or obtained.*[2]

No movement makes progress under indifferent generalship and no safety campaign was ever made a success under a half-hearted leader or a hypocrite. If the desire for safety expressed by the employer to his employes is not genuine, sincere and high minded, no one will be fooled for long *except the employer himself.*

M. E. Danford, Works Manager of the American Rolling Mill Company, declares:

[1] *Ibid.*, p. 165.

[2] Reninger, Henry A., "Safety in the Cement Industry," *Annals of the Am. Academy of Political and Social Science*, **123**, 212, p. 105, 1926.

Insincerity will be detected. Employes have a very keen appreciation of their employer and they can detect mockery or sham very quickly. They will not be fooled by a pretense on the part of the boss that he is interested in safety unless he shows by example and precept that he is in earnest.[1]

Success in accident prevention can come only through cooperative effort and cooperation is dependent on personal honesty, good faith and frankness. As already stated, many employers believe that the value of human life is such that all the cost of their accident prevention work would have been justified by the saving of a single life. It would be futile to argue the consistency of this simply because life cannot be definitely evaluated. In fact, to believe it is not requisite to the conviction that "safety pays," but the employer must regard human life, and even the life of his lowest and most unworthy employe, as a sacred thing placed temporarily within his custody which it is his duty to conserve even in the face of the man's own recklessness. And if, after an accident, the thought ever comes to him that "this man, for his folly, deserved to lose his life," he should know it as unworthy.

Man is given only one life on earth. When that is snuffed out he's through. He gets one body and when he loses any part of it, it is gone for good. Life and limb alike are irrecoverable. Mutilation is canceled opportunity. If cripples are the best arguments for Safety First the case is tragically proved beyond all appeal. If on the site of every tragedy due to heedlessness a monument should spring up, the nation would be a graveyard. Safety First is something more than a slogan. It is a prayer for protection from folly and carelessness. It is an invocation for men, women and children to preserve what they possess and never can regain if lost. It is a petition to the heedless to see that their recklessness destroys no one's life, and no one's limbs, and no one's happiness. It is the foundation of what some day must become an instinctive tradition for every child, that life's slender thread is Caution. Society multiplies its engines of living and doing, and with swift progress comes peril. None of those inventions equals the human body for perfection and frailty. Man commands both equally. But the one he can build and the other he cannot.[2]

The majority of the race believes in safety personally applied (the fundamental instinct of self-preservation takes care of it)

[1] "Industrial Safety," *Annals of the Am. Academy of Political and Social Science*, **123**, 212, p. 188, 1926.

[2] Editorial, *The Register*, Danville, Va., May 3, 1925.

and the greater part of the majority believes in safety for all. This, however, constitutes merely the passive acceptance of a principle and does not carry with it the practice of being safe or making others safe. Beyond this point the executive heads of many industrial establishments unfortunately do not go. If the employer is to make his establishment really safe he must in thought and mental attitude take the place of leader in safety to the same degree that he is leader in other things and with it accept the responsibility of active participation. Dr. R. M. Little, a recognized authority on safety and rehabilitation, has said:

> The management determines where a plant shall be, not the workmen. The management determines what sort of a plant shall be built, and not the employes. It is the management that determines what sort of machinery and tools and constructive operations shall enter into the the work shop, and not the working men. It is the management that determines how the plant will be lighted by day and by night. It is the management that determines what sort of air the men will breathe, and the kind of water they will drink. It is the management that determines how the plant will be approached, the entrance to, and the exits from it. All these basic principles are under the control of the management, and if the management wishes to inculcate in the workmen the principles and habits of safe practices, it is up to the management to discharge its own responsibility first, in order that the employe may get the atmosphere and practices out of which he will absorb the principles and the idea of safe practices. It is my judgment that the basic responsibility for forethought is with the managers, and if they are not forethoughtful you will not make much progress with the working men.[1]

The second fundamental in the employer's attitude lies in the demonstration of his desire to bring about a safe industrial establishment.

> The employer should make clear that he desires the cooperation and assistance of every employe in a mutual desire for safer working conditions, less accidents, less lost time, less cost. He must put the same energy into a campaign against accidents that he would into an endeavor to increase the tonnage or reduce the unit cost.[2]

Every man in the plant must eventually be reached so that no doubt lingers in his mind as to how "the big boss" feels.

[1] "Forethought *vs.* Afterthought in Safety," *Proc. Nat. Safety Council*, Seventh Annual Safety Congress, p. 189, 1918.

[2] Danford, M. E., *loc. cit.*

The recommendation is usually made that a general safety meeting should be held at which the plant manager addressing his employes shall tell them in unmistakable language what he intends to do in respect to accident prevention and what he expects them to do. This is admirable as far as it goes but *it is not enough.* In the author's memory there lingers the vivid impression of two safety meetings held for the executive and supervisory staff of a war-time plant of such a size that there were over 200 men on the staff alone. At the first meeting the manager, in a clear, forceful and impressive manner explained exactly where he stood and what he expected; at the second meeting, held a year later, it developed that many of the same men had entirely forgotten his earlier statements, were uncertain of his attitude toward safety and, as result, were themselves blundering hopelessly! This discovery gave him no little surprise as he had assumed that the effect of one public expression of his personal attitude would last indefinitely. On the contrary, a continual follow-up is as necessary in accident prevention work as in any other phase of industrial management.

If the manager's interest and intentions are sincere, his immediate assistants will soon learn it, but if it is left entirely to them to spread the word in whatever manner they think fit, the effect will grow weaker as it passes down the line. Except in a small plant, the employes will get little of it save a vague rumor, and in a very large plant it may not even reach all the foremen. In a month or so, moreover, the effect will have worn off and the situation will be little better than it was before.

What appears to be needed is a continued and far-reaching demonstration by the manager involving not only statements at general safety meetings and direct messages to his immediate assistants but a careful utilization of every opportunity that is offered to fix firmly in the mind of every employe the feeling that the management has set its heart on having a safe plant. If the manager is alert to recognize and accept them, he will find innumerable opportunities. He will place safety at the head of the list of subjects for his staff meetings and comment on the reports that are brought in. He will be keen to notice dangerous conditions or safety improvements on his trips around his plant and will ask direct questions of those in charge. He will be seen sometimes reading the contents of safety bulletin boards. If he notes an employe committing a careless act, he will send for his

foreman and his foreman's immediate superior and have the man warned. He will insist on looking over injury reports himself and will sometimes call in the heads of departments to explain why accidents have taken place. In these instances his questioning will be embarrassingly direct.

There is still more that he must do. He must promptly authorize all reasonable expenditures for safety and lay emphasis an the importance of having the work done thoroughly, substantially and in accordance with the best practice. He will insist on careful discussion of suggestions for safety and of recommended expenditures which are of doubtful value and, if refused or rejected, will see that the reasons for such action are frankly explained to their authors. He will exhibit a personal interest in medical treatment, compensation or other relief measures for injured employes or their dependents and will avoid any suspicion of a niggardly policy or of indifference to their losses or suffering. To an equal degree he will be merciless to the malingerer and to the indifferent or inhuman foreman and will be ready to let his best man go if he proves incorrigible in matters of safety, always realizing that, when all efforts have failed to make an unsafe man safe, his elimination, undertaken for the general welfare of the establishment, is justified, and the higher the position of such a man the more harm will result from his retention and the stronger will be the impression given by his dismissal.

There is one more thing that the manager will, or should do to emphasize his personal attitude, although it is not always the easiest. He must conform his personal habits to his mental attitude—in other words, make a safety example of himself. The author has seen plant officials who, having come before their men with an avowal of safety principles, crawled through moving belts, rode on freight elevators on which passengers were forbidden, exposed their unprotected eyes to processes where the use of goggles was insisted upon, drove their automobiles on plant thoroughfares at speeds far above the posted limits, entered without hesitation places where entrance was forbidden to all others and, in general, assumed risks and disobeyed safety rules for which any payroll man would have been disciplined or censured.

There are emergencies and other situations that justify the assumption of risk and the violation of safety rules, and it is

perhaps laudable that an executive does not fear to go into places of danger which are forbidden his men, but to do these things as a matter of personal convenience or in a spirit of contempt for danger or from a feeling of independence or superiority is small and unworthy. It is, above all, destructive to the safety movement and to the very mental attitude that the manager is seeking to inculcate in his men. It may be taken for granted that what he does, not only on the plant but in many places outside the plant, is seen and commented on by a surprisingly large number of his own employes. If he is to teach safety, he must practice safety, not only on the plant but when away from it.

Many have said that the foremen are the keymen in industrial accident prevention. Converting each foreman to safety may perhaps unlock the doors leading to the rank-and-file, but the master key to the entire establishment is its executive head. Until he is converted and assumes his proper responsibility, no effective and worthwhile safety work will be done. This has been ably expressed by Prof. A. C. Callen of the University of Illinois:

> One of the first advantages gained from a realization that safety is a spiritual thing will be the consciousness that it cannot be turned over to a safety inspector or a safety engineer if real results are to be secured. I do not mean that the active management of safety work should not be vested in a safety inspector if the organization is large enough to afford one, but I do mean that the appointment of the best safety engineer in the world will not solve the safety problem unless safety begins at the top of the organization and is a vital part of it.
>
> I believe that the best safety device is a careful man, and I feel sure that the best way to have careful men is to give them a good example of real safety living from the general manager right down the line. The burden of responsibility for maintaining a lively interest in safety rests upon the leaders of every organization with which the men come in contact. I tell you, in all sincerity, that the preaching of the "Gospel of Safety" cannot be accomplished by mere lip service on the part of officials. They must practice what they preach, and until they let their men see that safety is a part of them, something they are living every minute, we cannot expect anything, approaching continuous interest, on the part of the men.[1]

**"Safety First."**—The function of an industrial plant is to operate and produce. Whatever interferes with operation and

[1] "Practicing the Spirit of Safety," Address before Illinois Mining Safety Conference, *The Explosives Engineer*, **3**, p. 48, Wilmington, Del., 1925.

production is harmful; whatever promotes operation and production is essentially beneficial. Accidents interrupt operation, and safety work, when it actually decreases accidents, is beneficial and theoretically cannot interfere with operation. Yet every manager at times finds himself in a position where he is apparently called upon to decide whether an unsafe operation shall be continued for the sake of production or be discontinued for the sake of safety. While such a situation at first appears to deny the truth of the preceding statements, on closer analysis it generally resolves itself into a simple question of justification of monetary expenditures. In other words, will the expense of shutdown and changes which are necessary to make the operation safer be justified by the resultant reduction in accidents?

It is not our purpose to discuss in this chapter the savings that safety brings in either accident costs or greater production efficiency, and it will suffice to say that there are reasons for believing that the adoption of safer operating practices or equipment is very often reflected not only in fewer accidents but also in increased or higher grade production. In such cases the expense of shutdown and changes may be entirely justified by operating reasons alone, leaving any attendant accident reduction as a profit on the undertaking. Under other conditions where, after close study, no possible operating advantages are indicated in the change, one must give due weight not only to the direct and indirect cost of the accidents that will be prevented but to the moral effect on the plant personnel and particularly on its safety effort. When the issue is in doubt there should be no hesitation in following the order: Safety-quality-quantity which is a mere amplification of the slogan "Safety First." "Safety First" may have become a hackneyed and woefully misapplied phrase but it still contains the essence of a rule of conduct that is fundamental to the industrial safety movement.

The awkward cases to decide are naturally those in which large expenditures are involved and sometimes the entire rearrangement or reconstruction of an operating unit. Under such circumstances it is exceedingly difficult to determine in advance the extent to which safer operation, better working conditions, lower turnover, decreased waste of materials and power, lessened maintenance cost and enhanced production will result, and practically impossible to estimate the actual saving in dollars and cents. The executive, however, should bear in mind that re-

arrangement or reconstruction determined upon for the purpose of getting better results in only one line, if intelligently worked out and applied, rarely fails to improve other conditions as well. Indeed, one might assert that radical rearrangement or reconstruction never takes place without affecting improvements the value of which is reflected somewhere in lowered operating expense. That this must apply equally well to major changes made for safety is obvious.

**Giving Safety Its Proper Place.**—After taking up safety work and after the first pronounced reduction in accidents that follows it, many plants appear to reach a point where the injury record grows neither better nor worse and this in spite of continued effort, intelligent supervision and liberal expenditure. Naturally there is the usual fluctuation of injury frequency and severity but the rates as a whole, though neither very good nor very bad, cease to show a marked downward trend. Such a condition suggests the existence of something fundamentally wrong and, in the author's opinion, is often due to the way in which the safety work has been organized or is being conducted.

It is a truism that any industrial establishment will be safe when every man employed in it does nothing unsafe. In common parlance, "safety must be made a part of every man's job," which is to say that safety must dominate his mental attitude until it becomes a fixed habit. It is through guidance from within that all his actions can be consistently controlled and made safe. The exercise of immediate and continued supervision by the management to a degree sufficient to insure his not hurting himself or hurting others is inconceivable. The objective, therefore, of organized safety work should be the building up of safety responsibility in the individual employe. Any effort which leads away from this objective must necessarily decelerate rather than accelerate progress.

In introducing safety work it has been the accepted practice to adopt striking and sometimes spectacular methods to attract the attention and arouse the interest of the employes, and a safety organization of some sort is usually set up to get the work under way and keep it going. On a large plant the organization usually consists of a safety engineer [or the "service supervisor" or some other operating official to whom safety work is assigned in addition to his regular duties], a central safety committee and department, area or shop safety committees made up of foremen

or of the better grade operatives or both. An organization of this sort is practically indispensable for getting the safety work under way and maintaining it, but, strange as it may seem, a safety organization if not judiciously guided and controlled can indefinitely delay the advent of the time when a satisfactory degree of safety responsibility is established in the individual employe.

The root of the difficulty seems to be the failure of plant executives and safety engineers to differentiate between the initial and permanent phases of the work and between advisory and executive functions. The result of this is that the safety organization, primarily an initiatory and advisory body, is allowed to assume permanent functional duties which appertain properly to the operating force. Consequently foremen and operatives, instead of applying safety to their own duties and gaining individual safety responsibility thereby, come to rely more and more on the work of the safety organization.

The safety engineer, on his part, instead of devoting his time to what he is best fitted to do, is constantly at work on matters that are essentially a part of the accident prevention duties of superintendents and general foremen. Sometimes, instead of occupying a purely advisory position, he will be found clothed with semiexecutive authority, presiding at meetings where the manager or other operating executive should preside and issuing orders to operating superintendents and foremen. It is entirely natural that he should accept this authority if it is offered him, and it is natural for the operating superintendents and others to be satisfied to have him do their safety work if he proves capable and trustworthy. The system, however, is altogether wrong and leads farther and farther away from the establishment of individual safety responsibility.

One of the most brilliant safety engineers, at the head of one of the most highly organized, large-plant safety departments, failed utterly to bring his plant injury record to a respectable figure simply because there was too much safety organization and too little safety work done by the operating force as a whole. After he was replaced with a less able man and the plant manager had asserted that department heads would be held responsible for safety work in their own departments, the accident record commenced to improve. The fault in this case lay not so much with the safety engineer as with the plant manager

who permitted him to undertake the safety work of the entire establishment.

The usurpation of foremen's duties by safety committees is extremely common. Even in the case of plants that have been engaged in safety work for years, one is apt to find the minutes of safety committee meetings filled with recommendations on obvious defects that any experienced foreman is able, and should be required, to report or have remedied, such as broken railings, defective stair treads, missing guards, failure to wear goggles, unprotected floor openings and unsafe ladders. In the early days of the safety movement, such defects might not have been recognized as obvious hazards, so that it was necessary to have them uncovered by a safety inspector or a safety committee, but now that their true nature is a matter of common knowledge the operating organization should be required to correct them. It is a mistake to permit a committee to occupy its time with defects that can and should be normally remedied by the action of a single man. A committee or an expert may be properly concerned with the detection of previously unrecognized hazards or with checking up general conditions but not with duties that have become mere operating routine.

Aside from its function as an educational medium, the safety organization serves to initiate safety work and keep it under way. Probably it has no logically permanent place in the producing structure of the future. For the time being it has a function to perform, but advisory, not executive. It must survey, suggest, develop, correlate and stimulate the entire operating force into execution, but should never itself attempt to execute work that is essentially an operating function. If it does so, it frustrates its own efforts to make safety a part of every employe's duties.

**Summary of Fundamental Requirements.**—The fundamental requirements for successful safety organization may be summarized as follows:

1. Proper attitude on the part of the company and plant executives and willingness to take their part as leaders in the work.

2. Continued demonstration of their attitude by personal interest, by personal example, by precept and by action.

3. Application of the *principle* of "safety first" in settling questions in which safety and production appear to conflict.

4. To make safety a part of every employe's duties and not permit it to become the function of a single person, group or class.

A fifth requirement, which is obviously fundamental, is that the accident situation shall be ascertained and used for guidance in the prosecution of preventive work. This will be discussed in subsequent chapters.

## CHAPTER IV

## ACCIDENT INVESTIGATION AND ANALYSIS

James J. Hill, of railroad fame, once wrote: "Ample and accurate information is the best step toward success for everyone." Accident prevention cannot be intelligently and effectually applied to the conditions of work maintaining in any industrial establishment except on the basis of knowledge of accident experience. To some extent this experience may be that of others; in other words, such information on accident cause and occurrence as can be gathered from known experience of similar establishments. However valuable this may be to the industrial executive or safety engineer, it is manifestly of less importance to him than the, experience of his own establishment. Lessons from the latter are learned in two ways: by study of mass experience (accident tatistics) and by scrutiny of the individual accident.

> The most valuable knowledge we possess is that which comes through making a mistake—through experience. Accidents are mistakes as well as experience. To realize on an accident is collecting revenue from the refuse.[1]

We cannot get the full value out of accident experience unless we are able to interpret the meaning of individual accidents and, in particular, uncover their true causes. First of all, we must be certain of exactly what we mean by the word "accident."

**Definition.**—The words *accident* and *injury* are loosely and often incorrectly used. They are by no means synonymous.

A common definition of accident is "an unforseen occurrence, usually untoward or disastrous." An accident is, literally, a "befalling," an event unexpected, at least as regards its precise *time* of occurrence. The word *casualty* usually denotes an accidental occurrence involving bodily injury, but *accident* does not imply that bodily harm or even property damage results. It is in this sense that we shall employ it.

[1] RUTLAND, C. J., "Report of Accident Causes and Remedies Committee of Public Utilities Section," *Proc. Nat. Safety Council*, Twelfth Annual Safety Congress, p. 869, 1923.

An accidental injury, or what we shall merely call *injury*, is the result of an accident but neither its inevitable nor necessarily its only result.

**Causation.**—Under the above interpretation, accident and injury become separate though usually consecutive events with a causative relationship. While it is true that the accident causes the injury, the cause of the accident and the cause of the injury may be, and usually are, entirely distinct. The cause of accident may be almost any train of circumstances; the cause of injury may be external violence, such as contact with moving machinery, or internal violence, as in the case of poisons. A study of the following examples will make this clearer:

| Accident | Injury | Accident cause | Injury cause |
|---|---|---|---|
| Scaffold failure. | fracture of thigh | scaffold overloaded | 30-foot fall |
| Picked up wrong bottle | bichloride of mercury poisoning | insufficient light—ordinary bottles | swallowed poison |

In passing, it should be noted that either of the above accidents could have happened without causing actual injury. In the first case, there might have been no one on the scaffold, or the employe on it might have caught himself and averted the fall, or have fallen on soft ground and not hurt himself. In the second case, the person concerned might have realized his mistake before swallowing the poison or might have picked up a bottle the contents of which were harmless. The distinction between accident and injury should always be kept clearly in mind.

**Proximate and Remediable Causes.**—Most accidents are not the result of a single, well-defined cause but of a train of events or combination of circumstances each of which contributes in some degree to cause the final accident and consequent injury. Many superficially simple industrial accidents arise out of a highly involved network of condition and circumstance. They appear simple solely because we do not make the effort to trace the causative relationship to its source and are content merely with what is termed *proximate cause*. The proximate cause may or may not be the cause which it is most desirable or efficacious to remove in order that future accidents may be prevented. The only way to find out is to ascertain all the

causes and then determine which are remediable and, in particular, what we may term *the principal remediable cause.*

A definition of proximate cause is "a cause which directly, or with no mediate agency, produces an effect or a specific result." It bears, therefore, the closest causative relationship to the accident of any of the contributing events or circumstances. The *principal remediable cause* may be defined as that cause which is most readily and effectively remediable, and the remedy of which will go farthest towards removing the possibility of repetition. This term which has, to some extent, originated with the author, seems to adapt itself to the recommendation of the Committee on Statistics and Compensation Insurance Cost of the International Association of Industrial Accident Boards and Commissions, that accidents be assigned to their "proximate and immediate cause." In defining this they stated that:

> . . . the accident should be charged to that condition or circumstance the absence of which would have prevented the accident; but if there be more than one such condition or circumstance, then to the one most easily prevented.[1]

**Analyzing the Accident.**—For the purpose of analysis let us assume a case: A house chimney takes fire at night when some excelsior is being burned in the fireplace. In an effort to extinguish it, the owner goes out upon the shingle roof, inadvertently treads upon a short piece of loose pipe that has been left there by workmen, slips, rolls off the roof and falls upon a wheelbarrow standing below.

The proximate cause assigned would in all probability be "fall from roof." In reality, this coupled with "falls on wheelbarrow" is the proximate cause of injury. There are really two accidents, the chimney on fire and the slipping, falling and rolling of the man on the roof. Both are unexpected and each has several causes. The loose pipe, the uncleaned chimney and the burning of excelsior in the fireplace are remediable. The roof is a dangerous place, especially at night, a shingle roof is an admitted fire risk and dirty chimneys may ignite at any time. The principal remediable cause is presumably failure to clean the chimney. In the background is the prevalent condition of poor

[1] *Standardization of Industrial Accident Statistics, Bull.* 276, U. S. Bu. *Labor Statistics, p. 33, 1920.*

housekeeping which manifests itself in several ways, all of which contribute to the resultant injury.

Is such hair-splitting analysis of accidents and their causes really necessary? If the remediable causes are to be ascertained and their remedy applied, it is. Local conditions do not always make it possible to analyze minutely every accident, however, and there are human and practical considerations limiting the extent of such analytical efforts. Careful analysis should always be made of serious or repeated accidents and, in the prosecution of safety work, accident causes should be constantly probed deeper as the work proceeds.

Not even the commonest type of accident should be dismissed on the assumption that it is too obvious to require careful inquiry and analysis. Let us take a hypothetical case, a common nail puncture of the foot, and see what it reveals. A machinist's helper carrying a tray on his shoulder stepped on a nail which protruded from a small piece of loose board lying directly in his path. Investigation reveals:

1. The board was part of a crate.
2. The contents of the crate had been unpacked at a proper place but the portion in question had dropped unnoticed from a truck loaded with similar pieces which were being moved away for proper disposal.
3. The truck had been piled too high, was not intended for such duty and was pulled along when it should have been pushed.
4. The board fell at a point where the aisle was congested with castings to be surfaced on a near-by planer.
5. The castings threw a shadow across the aisle at this point.
6. The nature of the load carried by the injured man prevented his seeing where he stepped. He did not see the board.
7. The soles of his shoes were worn through.
8. He did not report the injury for 2 days by which time the wound had become infected.

*Conclusions:*

*A*. Improper truck. (Fault of management.)

*B*. Careless loading and improper handling of truck. (Fault of truck operator and of labor foreman.)

*C*. Aisle constricted. (Fault of shop foreman.)

*D*. Unsatisfactory illumination. (Fault of management.)

*E*. Load being carried prevented clear vision. Trays should have been trucked. (Fault of shop foreman.)

*F.* Insufficient protection for feet. (Fault of injured.)

*G.* Failure to report injury. Injured had been instructed. (Fault of injured.)

The failure to report for treatment affected the severity of the injury but had no bearing on accident causation. Insufficient foot protection was not an important factor since a reasonably sound sole might have been penetrated. The constriction and lack of illumination of the aisle were contributory and remediable but such an accident might have happened even had they been corrected. Had the injured been able to watch his step there is no assurance that he would have done so and that all others would have done likewise; therefore *E* while contributory and to some extent remediable is not of major importance.

Unquestionably the management should have provided a more suitable truck and the foreman should have insisted on its proper use, but it was within the power of the truck operator to prevent the board falling off and to pick it up if it did fall. If it had not been dropped and allowed to lie, the accident would not have occurred and no one would have been endangered. The immediate remedy would be the issue of orders that four-wheel trucks operated by one man must be pushed, not pulled (thus obviating the probable occurrence of several other types of truck accidents), that trucks must not be overloaded, and that anything dropped from them must be picked up at once by the truck operator. Other necessary changes, orders or instructions would follow.

This accident is interesting because its analysis reveals widespread responsibility as well as the existence of conditions affecting general shop operation. In most instances, such an accident would be reported merely as "stepped on projecting nail—failed to report for treatment," and the prescribed remedy might be "more care," "safety first," "better housekeeping" or "men to report all injuries." Such recommendations are good as far as they go, but unfortunately they go nowhere. Their appearance is general advertisement of the fact that no thorough investigation has been made or the investigator has left the more difficult part of his work for someone else to do.

The following case, a mine accident, is quoted because it well illustrates the advantages of close analysis:

John was killed and the accident report gave the cause as "fall of rock." He had been barring down "loose" for 15 or 20 minutes and just as the accident occurred he was standing on one rock and barring

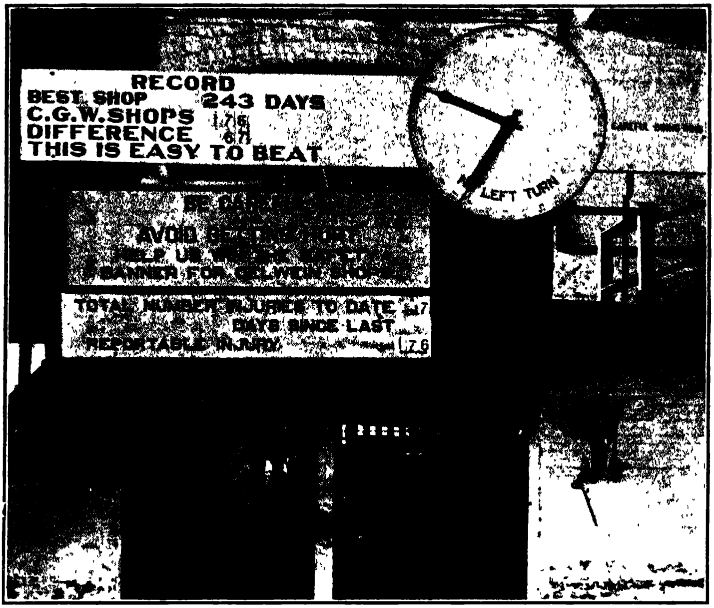


PLATE Va.—No-accident Score Board - Chicago Great Western Railroad. (*Equitable Life Assurance Society.*)

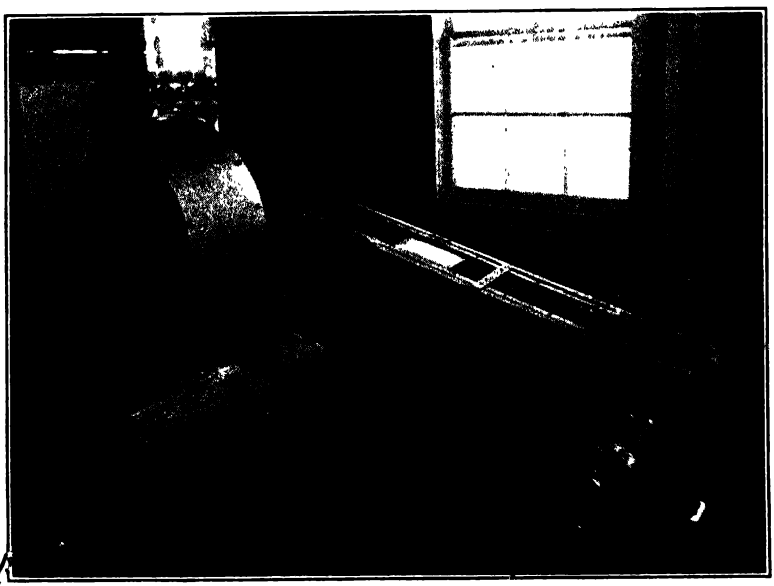

PLATE Vb.—Guard for Small Motor Drive. (*E. I. duPont de Nemours and Company.*)

(*Facing page 50*)

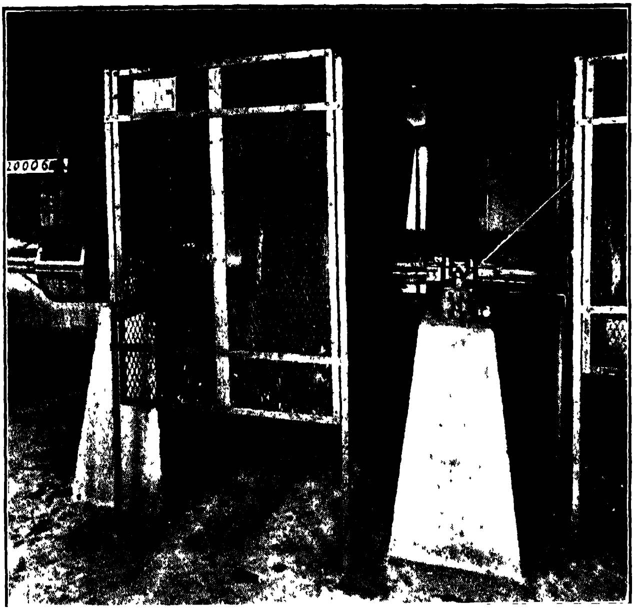


PLATE VI*a*.—Guards for Line Shaft and Drives. (*E. I. duPont de Nemours and Company.*)

PLATE VI*b*.—Safe Reeling and Inspection of Goods—(note visibility of all rollers and clear working space). (*E. I. duPont de Nemours and Company.*)

(Facing page 51.)

down another when a third fell squarely on top of him, killing him instantly. When his partner was questioned regarding the occurrence it was found that John was attempting to bar down the boulder with a piece of 8-pound rail 12 feet long. He could hardly lift it comfortably let alone work efficiently with it. The partner was then asked if they had "sounded the roof" to see if it was "drummy." "Hell, no," he replied, "What do you mean drummy?"

Now we have it. This fatality was not caused by "fall of rock" but: first, by using improper tools (an 8-pound rail for a bar); second, the man was physically tired, he had been trying to use poor equipment so long that he was practically exhausted; and third, improper mental training as no one had told him how to sound the roof for dangerous pieces of rock that would be liable to fall—for proper instructions regarding the work is just as important in accident prevention as proper tools. Furthermore, his partner was peeved and he must have been because they were using an old piece of 8-pound rail when most of the other men had light bars built especially for such work. Consequently he was also working under a psychological handicap in that he felt he had been discriminated against by having to do this work with such tools.[1]

**Accident Investigation.**—From the foregoing the reader may gather that most careful, searching investigation of accidents is necessary if the maximum advantage is to be gained from their occurrence. This will require not only a study of the scene of each accident but also an intimate acquaintance with existing operating conditions and with the personality of the individuals concerned.

It is hardly probable that any one man acting in the capacity of an accident investigator can invariably meet these requirements even in a small plant, nor can he supply all the information that the individuals concerned in the accident can furnish if they so desire. To obtain the full story it is necessary that the department involved make an official investigation through the normal channels of its operating organization. But to develop the fine points, arrive at constructive conclusions and avoid any possible bias from the operating viewpoint, it is also necessary to have an investigation by some qualified individual, such as an accident investigator or safety engineer, who has the time, opportunity and incentive to investigate as many accidents

[1] AGETON, R. V., "A Few Thoughts on the Use of Positive Suggestive Psychology in Accident Prevention Work," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, **1**, p. 578, 1925.

as possible and keep in step with the advance of the safety movement.

Local conditions will determine whether these should be separate investigations or combined. If the former, some "board of review" will be necessary in order that the full, balanced value of the two reports may be had with the adjustment of any conflicting findings or recommendations. The manager of a small plant may act in this reviewing capacity and, on a larger plant, the central safety committee. In whatever way the review is conducted the authors of each report, or at least representatives of both sides, should be present in order that they may themselves derive the full benefit from discussing the case. This subject will be mentioned again in later chapters.

**Detection of Causes and Prevention.**—While the detection of all the remediable causes of an accident is most important, it does not follow that either the proximate or the principal remediable cause is necessarily the logical point for applying prevention. Careful analysis of a group of accidents may disclose the constant appearance of the same contributory cause in all of them, in which case it may well be that greater progress can be made through concentrating on its elimination than upon the prevention of a number of separate and widely different proximate causes. In the roof accident, mentioned in a preceding paragraph, poor housekeeping made its presence obvious in three separate ways and might be considered a very reasonable point of attack. In the nail puncture case, previously cited, it is entirely possible that the removal of protruding nails from crates, boxes, etc. as soon as unpacked would have been the most logical preventive step to take.

There are many accidents the injurious results of which may be guarded against by removing the *injury cause.* The use of goggles, respirators and other personal protective appliances are examples of this. Nevertheless, it should be noted that, notwithstanding such protection, the *accident hazard* has not been effaced and injury may result if the protective appliance is not in use at the moment or fails to function properly. This is equally true of such protection as machine and power transmission guards; their mere presence is an indication that the existence of a proximate accident cause has been recognized and guarded against, but not eliminated.

# CHAPTER V

## CHANCE AND PROBABILITY

The safety movement seeks to substitute for an almost universal belief that "accidents will happen" a new doctrine, "accidents are caused and their causes are preventable." Mankind clings tenaciously, however, to its early concepts of "luck," as it clung for centuries to firm belief in witchcraft, and will not be shaken out of the fallacy that accidents are wholly fortuitous. Because this constitutes no inconsiderable obstacle in the path of conversion to safety principles, it merits more than passing notice.

**Definition of "Chance."**—A dictionary definition of the word is a "hypothetical agent or mode of activity other than force, law or person." This interpretation, however, concerns itself with chance as a cause of events, a use of the word which has been generally abandoned in scientific and philosophical circles. In other words, it is no longer customary to regard chance as capable of *causing* anything, even accidents. It is applied rather to the culmination of events; that is, when an event is unpredictable, it is said to be due to chance.

We may not be able to foresee the occurrence of an accident but after it has taken place we are generally able to explain the reasons for its occurrence. Where we experience difficulty is in determining why it took place at the precise moment it did. This is the point at which the word "chance" proves useful, but we must be careful not to employ it in a causative sense. It must be remembered that by far the greater number of accidental injuries is the result of sudden and unexpected application to the body of mechanical or other forces which its structure is unable to resist properly, and the action of these forces is governed by laws which are fixed and usually well understood. It would seem highly improbable then that the *accidents* which caused the injuries were the result of the working out of other than fixed laws, even though the laws might be too complex to be readily comprehended.

Since we may properly apply the word "chance" only in connection with the culmination of events, it becomes practically synonymous with the word "possibility"; indeed, the latter word is a much safer one for general use since it is not used to express agency, is never endowed with a fictitious personality like "chance" or "luck," and cannot be employed in the causative sense.

**Definition of "Probability."**—The difference between *possibility* and *probability* is recognized by all.

> We call an event *impossible* when we cannot think of a single cause in favor of its occurrence, and *certain* when we cannot think of a single cause antagonistic to its occurrence. All the different "shades" of probability—improbable, doubtful, probable—lie between these extreme limits.[1]

While *probable* and *improbable* are, like most words, loosely used in everyday conversation, since 1654 the theory of probabilities has been a subject of mathematical research which has tended to remove it from the purely speculative zone into the realm of exact science. In 1812 Laplace wrote:

> . . . the theory of probabilities is nothing more than common sense reduced to calculation. It determines with exactness what a well balanced mind perceives by a kind of instinct, without being aware of the process.

It is not within the scope of this volume to go far into a subject which has its place in higher mathematics. What it is desired to emphasize is that there exists a theory or doctrine of probabilities which deals with the maturity of complex events and brings their occurrence under exact laws as against leaving their happening to random conjecture. Some of the elements of probabilities are known to most players of "games of chance,"[2] and cards and coins are convenient media in which to express the application of a few of the elementary laws.

**Simple Probability.**—Take a pack of cards, shuffle, lay them face down on the table and attempt to draw the ace of spades. Success is improbable, but if the ace is drawn in the first few

[1] MELLOR, J. W., "Higher Mathematics for Students of Chemistry and Physics," 3rd ed., p. 498, Longmans, Green & Co., New York., 1909.

[2] An interesting discussion of probabilities, in popular form, will be found in "Hoyle's Games."

attempts it will be ascribed to "luck." It is not, however, a matter of luck, but follows the laws of probability. If the operation is repeated a great number of times, it will be found that other cards are drawn on the first draw fifty-one times as often as the ace of spades. Provided there are always 52 cards and the pack is shuffled each time, the chances of drawing a specific card are always 1 in 52, no matter how often the attempt is made. In other words, the odds against it are 51 to 1.

One of the laws of probability is that where there are any number of independent events the probability that they will all happen is the product of their respective probabilities. Therefore the chances of drawing a specific card twice in succession are 1 in 52 × 52 or 1 in 2,704. If, however, it has already been drawn on the previous trial, the chances of uncovering it on the next draw are, as before, 1 in 52. This can be made clearer if we analyze the chances in tossing a coin.

A coin must fall either heads or tails, and the chances for it falling either way are exactly even.

If, however, a bet is made that it will fall heads twice in succession, the odds against it are 3 to 1. This is because there are four possible combinations: tails—tails, heads—tails, tails—heads, heads—heads, and three of these combinations lose while only one wins. If one bets that the coin will fall heads three times in succession, the odds against it are 7 to 1 because there are eight possible combinations of which only one can win. The progression is rapid and the odds against heads ten times in succession are 1,023 to 1. In all cases, however, these odds apply only to conditions existing before the coin has been tossed and for the whole series of tosses. The chances for each separate toss are invariably even, no matter what has transpired previously.

**Maturity of Chances.**—Unconscious emphasis on the improbability of a certain event happening with any definite regularity is apt to lead us into grave errors. While realizing the possibility of accidental injury from a given cause we are prone to believe that, because it has never happened to us, it never will happen. This is the "fool's paradise" of the chance-taker.

There is another and somewhat similar resort of the "unlucky" who, having been injured unexpectedly, believe devoutly that such unexpected occurrences are all the more unlikely ever to happen again. As a matter of fact, a preceding event that has or

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has not transpired has no bearing on the probability of occurrence of a future event to which it is not directly related. In the preceding example it did not matter how often the coin had fallen heads; the chances of its going heads in the succeeding toss were exactly what they always were—even. Likewise, in attempting to draw the ace of spades from the pack, the chances were 51 to 1 against drawing it, no matter what had been the results of previous trials. If my chances of not being struck by an automobile at a certain street crossing are 50 to 1 (a chance of 1 in 51), the odds against being struck twice in succession are 2,601 to 1. Nevertheless, it matters not whether I have crossed a thousand times without mishap or was struck yesterday; my chances today are still 50 to 1.

This is what is sometimes called "maturity of chances." Failure to understand it has cost gamblers thousands of dollars and has probably cost many chance-takers their lives. It applies, of course, only where the maturity of events is free from predisposing influence; it would not apply, for example, with loaded dice!

**Compound Probabilities.**—We know that but few accidents are the result of a single, simple cause and in most cases occurrence is predicated on the simultaneous fulfillment of a flock of antecedent conditions. It is doubtless because of the complexity of the situation that we fail to realize that the laws of probability are at work. Each of the factors, nevertheless, contributing to the accident, whether cause or condition, has presumably its own probability of occurrence and, if these factors are independent, the probability of the occurrence of the accident is their arithmetic product.

For example, from an intersecting street I arrive with my car at a thoroughfare on which vehicles are traveling in a single lane uniformly at the rate of 30 miles per hour and 10 vehicles per minute. If the average car length is 15 feet, the average distance between cars is approximately 250 feet. Assume that my chances of striking a car, if I do not slacken speed to cross, are 1 in 265. If the chances that I can apply my brakes in time to avoid trouble are 1 in 4, the chances of a collision become 1 in 1,060.

To take another example: If the chances of sudden failure of the crane sling of a traveling crane when under load are 1 in 10,000 and the hooker-on is under the load a total of 10 minutes

in every 10-hour day, the probability of his being struck if the chain breaks is:

$$\frac{1}{10{,}000} \times \frac{10}{10 \times 60} = \frac{1}{600{,}000}$$

If, however, there are even chances that he will have some warning and get away in time, the probability of his being struck will become 1 in 1,200,000.

These examples are given not because the deductions have any intrinsic value, or even approximate the truth, but to illustrate the thought that behind the obscurity of complex conditions surrounding most accidents is an orderly consummation of events which would be susceptible of prediction if their individual probabilities could be determined. Such being the case, chance in the sense of *luck* dwindles to mere nothingness.

Unfortunately mathematical determination of the probability of separate causes and conditions is not practicable—is, in fact, often beyond assumption. It might, for example, be entirely possible to ascertain how often firearms that were supposed to be unloaded had been accidently discharged with fatal results, but it would be utterly hopeless to attempt to discover how often they did not go off under such circumstances. Without this information, or lacking the total number of handlings resulting either harmlessly or fatally, it would be impossible to calculate the probability of fatal accident occurrence.

**Volition.**—What has been said in preceding paragraphs refers primarily to physical forces and physical laws rather than to the actions of human beings in response to their wills. It is plain that the working out of any law of probability may be upset by *voluntary* exposure to injury, or even by involuntary and unconscious exposure by one who is above or below normal. Probability so far as it applies to accidents is, in the ultimate analysis, based on *average performance* and the individual who departs from the normal is, in a sense, outside the law. This, however, does not mean that chance is a factor of greater importance in his career but rather that his probability differs in some degree from the average.

In the case of the subnormal individual, predisposition to injury is neither "bad luck" nor volition, but usually lack of intelligence in some form. The following case is typical and is based on actual facts:

A young man, raised on a farm, was employed by a construction engineer. He was given a hatchet to sharpen stakes for surveyors and from attempting to do this on the rail of a railroad track, cut his leg. On his return to work he undertook to sharpen the stakes on a circular saw and cut off several fingers. To keep him out of further trouble he was assigned to wagon driving, but soon after was detected in the act of trying to force a jack knife downward through a leather trace which he had laid on his knee. He was discharged after being discovered plaiting the hair in a mule's tail! Later experiences at another job included backing a wagon into a deep ditch and driving a cart over his own leg. His employer described him as "an expert fool—born a fool and became a bigger fool as he grew larger."

Such a man, creating his own hazards, invites an accident experience above the normal. Between the extreme of such a type and the average are thousands of the so-called "unlucky."

**Increased Exposure.**—In the example of the failing crane sling it was found that the probability of injury was only 1 in 1,200,000. A million-to-one chance seems exceedingly slim but remote chances are often offset by continued or increased exposure. In many years' experience in the manufacture and handling of smokeless powder prior to the war, only one instance occurred on plants of the duPont Company of the ignition of a grain of powder by friction against a wooden surface. It was regarded as a "freak performance" or was openly discredited. To meet war demands, however, production of powder was vastly increased, and with this increase the instances of similar ignitions multiplied, until the hazard was admitted and guarded against. The probability of occurrence did not change but the exposure or "spread" of experience was amplified.

The probability of injury at a street crossing may remain constant or may increase with increasing traffic, but, if a greater number of crossings are demanded of the individual, his chances of injury are correspondingly increased. Similarly, the increasing number of persons killed by automobiles is not an indication that each automobile is a greater hazard than formerly, but is merely the outcome of the increased number and use of automobiles, the natural result of which is increased accident exposure.

Exposure to accident and accidental injury is a subject of extreme importance to the student of accident prevention and will be frequently referred to hereafter.

# CHAPTER VI

## RESPONSIBILITY

The human factor occupies a dominant position in the causation of accidental injuries, hence the determination of responsibility is a matter of no little importance. For reasons that will appear later, however, statistical information on responsibility for injury causation in any given industry, or in industry as a whole, is of very little value and is apt to lead to fallacious generalities. The determination of responsibility is of most use as an aid to analysis of the individual accident. The summation of responsibilities for accidents within a given plant is valuable as directional guidance for educational safety work.

**Fixing Responsibility.**— While determination of responsibility may in the end lead to reprimand, discipline, penalty or even lay-off for employes who have disobeyed rules, jeopardized the lives of others or who have themselves become an intolerable menace, its primary purpose is to permit intelligent formulation and application of corrective measures. It should not, then, be permitted to take the form of an attempt to discover which person was responsible for a given accident, but should be an effort, conscientiously and impartially made, to arrive at some estimate of *the relative responsibility of all concerned*—the injured, his fellow employes, the foreman and, invariably, the management. Obviously there is no question here of "guilty or not guilty"—no justification for approach with the legal attitude of mind. A broader purpose than that of punishment is to be served. A knowledge of facts is desired so that correction may be applied.

It is true that the simplest way out of the tangle of causes and circumstances that are brought to light by thorough accident investigation lies in the selection of a *single cause* and a *single responsibility* for each accident, and this greatly simplifies any ensuing statistical procedure, but since accidents occur as the result of combinations of circumstances or causes, the responsibility for all of which can rarely be attributed with any fairness

to a single individual, any tendency to fix the blame on one man or regard responsibility as analytically indivisible will ultimately cloud rather than clarify the issue. A notable example of this is the oft-repeated statement that 75 to 90% of industrial accidents are the fault of the men themselves. It may be true that even so large a portion of industry's casualties could have been obviated by things which the men might have done but did not do, but it is equally true that a very large number of the same accidents could have been prevented by some things which the employer or his immediate agents could have done but did not do. In the author's opinion, the statement as usually made is not only fallacious but, by causing resentment on the part of those whom it is intended to correct, has hindered rather than hastened the progress of the safety movement.

It is usually difficult to determine to what degree the participants in an accident were responsible for its occurrence and for the resultant injury, but not hard to decide whether a given individual had some responsibility or none whatever. This, however, presupposes that all the facts are uncovered and that judgment is delivered with absolute impartiality. Avoidance of any appearance of "whitewashing" the plant management is imperative, even though it may be regarded as somewhat affecting legal liability. Determination of responsibility on the basis of anything except truth and impartial judgment is mere wasted effort.

**Responsibility Classification.**—The simplest comprehensive classification is the following:

1. Responsibility of injured.
2. Responsibility of fellow employe (non-supervisory).
3. Responsibility of foreman or other supervisor.
4. Responsibility of management.
5. Responsibility of other than employer or employe.
6. Unassigned.

A more complicated classification adapted from earlier German practice is as follows:

1. *Impersonal.*
   *a.* Act of God.
   *b.* Physical deficiency (not previously recognized).
   *c.* Risk of employment.
2. *Personal—Fault of Employer.*
   *a.* Defective construction or equipment.

*b.* Lack of proper safety appliances.
*c.* Lack of proper supervision.

3. *Personal—Fault of Injured.*
   *a.* Negligence or lack of skill.
   *b.* Disobedience of rule or instructions.
   *c.* Non-use of safety appliances.
   *d.* Failure to report injury.
4. *Personal—Fault of Fellow Employe.*
   *a.* Negligence or lack of skill.
   *b.* Disobedience of rules or instructions.
   *c.* Non-use of safety appliances.

This classification has been in use for a number of years by the duPont Company and has proved generally satisfactory. While it is not recommended as superior to other classifications, discussion of its application will serve to bring out points of possible value to the reader.

*Act of God.*—The insertion of such a caption is not intended to suggest a denial of divine intervention in any but one class of accident but rather to provide for the segregation of accidents brought about solely by natural forces, such as lightning, earthquakes and windstorms. While it is incontestable that we know, as yet, very little about the prevention of accidents of this sort, since the natural laws governing their occurrence and behavior have not been discovered, there are usually ways in which the probability of injury from them can be increased or diminished. For example, it would be misleading to classify under "Act of God" the death of an employe who had deliberately taken refuge under a tree or had been handling an electric wire during a violent thunderstorm. Death or injury which could have been avoided by exercise of common caution is not "impersonal" and should not be attributed to an "Act of God." Injury resulting from a fall is never classed as "Act of God" and yet the force of gravity has presumably the same divine authorship as the forces of lightning, earthquake and windstorm.

*Physical Deficiency.*—This caption is applicable to cases in which abnormal or subnormal physical condition or ability, *not previously recognized or readily recognizable*, is the proximate cause of the accident and not merely contributory to the severity of the injury. It is not applicable when injury results from internal causes in no way arising from or aggravated by the employment.

Cases that are properly assignable to any other class of responsibility should be carefully excluded from this category, for example, strains due to the injured's failure to recognize his own physical limitations and injuries resulting from the employer's failure in one or more of the following respects:

1. No physical examination on employment.
2. No consideration given to physical or mental limitations when assigned work.
3. Foreman indifferent to condition of his men.
4. No instruction in manner of performing work.
5. Not provided with suitable appliances for work or for protection.
6. Not provided with reasonable assistance for performance of duties.

Neither are such accidents "impersonal" nor are they due to physical deficiency. They are, in fact, assignable to lack of proper supervision, for which the employer is responsible.

Employers are also principally responsible for a large number of accidents to which imperfect eyesight or hearing, subnormal coordination or reaction, malformations or deformities, or poor or impaired mentality are contributory, provided the defect is recognized and reasonable precautions are neglected, or the defect is not recognized though reasonable diligence on the employer's part would have led to its detection. Most hernias would fall naturally in this class were it not for the fact that they are now recognized as of non-occupational origin except in rare cases which are actually traumatic. That the existence of a hernia is revealed accidentally, or that its final stages of descent are accelerated by the nature of the occupation, or that it is adjudged compensable, does not seem to alter the case.

Defects such as the above are apt to make their first public appearance at the employment office, where adequate physical examination should show them up, or among employed men of advanced age. While the hazards of the older men are discussed in subsequent chapters, it may not be amiss to observe here that the fact that they have been safe workers in the past is no guarantee that they will remain so to the end of their days. Advancing age handicaps us all, and does so despite our wishes to remain physically and mentally alert. Such men, as a class, need physical examination far more urgently than they did in their youth but, when continued in their employment, are less likely

to get it. Those who ought to retire from active work are usually loath to do so, not having saved sufficient to support themselves. They are equally loath to admit the existence of physical handicaps which might affect their employment.

Many employers, on the other hand, have no fixed policy on retiring elderly employes and no pension plan. Pension plans, moreover, provide for employes of long service but rarely for the late comers; consequently, regardless of physical handicaps, such men are impelled to work and cannot be blamed for seeking continued employment at their old trades even if unfitted for them. If such men are injured under the circumstances, their employers should assume their proper share of the responsibility.

*Risk of Employment.*—There are objections to the introduction of a classification of this sort for, in practice, it is apt to be used as dumping ground for all cases which have not been subjected to careful analysis or for which the employer is reluctant to assume his proper share of the responsibility. In other words, "risk of employment" is frequently used as an "alibi."

One occasionally sees tabulated results of analysis for responsibility assigning to risk of employment as much as 45% of the total accidents. It is entirely possible that 45% of a plant's severity rate could be assignable to risk of employment, but hardly 45% of its frequency rate. More careful analysis would probably reduce the assignment to a figure between 15 and 30%. Some hazards are of infrequent occurrence, obscure or difficult to obviate, but this does not mean that the injuries they cause are essentially unavoidable. If such a classification has any lasting value at all, it would be realized through interpreting it to mean "hitherto unrecognized risks of employment."

**"Unavoidable" Accidents.**—The three subcaptions under the heading *Impersonal* make up the group usually called "unavoidable accidents." Since we have found that there are apparent difficulties in the application of any of the three to actual accidents, the question arises: Are there such things as "unavoidable accidents?" To the reader who regards the words "accidental" and "unavoidable" as practically synonymous this may seem rank heresy, especially if he has grown into the habit of accepting without question the adage "accidents will happen."

As stated in a previous chapter, the average person believes that luck has a great deal to do with his being involved in an accident, luck being not necessarily a thing totally detached from

the luck of other men but rather the disposition of his own fortunes by an inscrutable, uncontrollable agency affecting the lives of all, which may be personified as Fate or Chance or, more piously, the Hand of God. The average individual accepts, though somewhat whimsically, symbols of luck and symbols of misfortune; the number 13 is to be avoided; accidents always happen in threes; one must not walk under a ladder or sleep in the moonlight. Such symbols are supposed to affect one's luck, and with it, the chance of accidents. Have they a basis of truth or are they a relic of the superstitious middle ages, removed but one stage from the mumbo-jumbo of savagery? Only one generation ago men believed that fresh night air was fever-laden and that frequent bathing depleted vitality! Or, when we blame "bad luck" for accidents, is it merely a conventional gesture intended to quiet the conscience and distract the attention of others from our awkward position?

When one reviews the reports of common industrial accidents, many cases are found for which no specific means of prevention can be suggested. It is in such cases that the investigator, at loss for a really tangible remedy, has recommended "more care," "get the safety habit," "use Safety First" and similar measures, largely by reason of his unconscious inclination to dodge a troublesome question by recourse to generalities. Are such accidents really as unavoidable as they seem to be when one considers them on their individual merits?

Perhaps we cannot give a definite, affirmative answer to the above question, but experience has repeatedly shown that when the employes of an industrial establishment are imbued with a strong desire to prevent accidents, and have the moral and financial support of the management, accidental lost-time injuries cease, including *those of the type usually called unavoidable for which no reasonable and practical means of prevention can be suggested*. Scores of industrial plants have conclusively demonstrated this, and to accomplish a no-accident record of 1,000,000 man-hours is now no longer a startling accomplishment, as will be noted from the figures given in Chap. II.

Records of this sort are too numerous in plants that are doing good safety work, and too infrequent in plants that are doing none, for them to be "freak performances." Indeed, they are achieved only as a result of continued effort. Furthermore, the accidents which interrupt the continuity of consecu-

tive no-accident periods usually present no extraordinary aspects but are of the common sort that took place frequently before the advent of the safety movement.

It would be presumptious to assert that the existence of unavoidable accidents has been absolutely disproved by industrial experience, although the author believes that the time may come when it will be an admitted fact. We may at least urge the importance of ascertaining the causes of each accident, however, no matter how "unavoidable" it may at first appear, of fixing responsibility and of selecting the best means of prevention. To accept an accident as "unavoidable" or the result of "bad luck" gets us nowhere and is a tacit admission of defeat in controlling what others have found it quite possible to control. In view of this experience, it is the author's opinion that there is little or no justification for classifying accidents as "avoidable" and "unavoidable" and that doing so simply clouds the issue.

**Major Division of Responsibility.**—The major division of responsibility must of necessity be among employer, injured and fellow employe. The term "fellow employe," however, should be applied only to those of rank approximately equivalent to that of the injured. Thus, if a laborer is injured through fault of his foreman, the responsibility should be assigned to the employer rather than to "fellow employe," since foremen, supervisors and superintendents, as agents of the employer, are presumed to be acting under his direction. This is based on the premise that the function of supervision vested in the employer is delegated by him to his assistants and passes down the line to, and includes, the foreman. This seems to be the only tenable position if it is admitted that accident prevention is to be made part of the regular duties of every employe.

## CHAPTER VII

## ACCIDENT RECORDS

A complete and permanent record of individual injury cases and of the plant's accident experience, as a whole, is essential to good industrial management. Even the small industrial concern which employs but few men, has infrequent accidents and shifts its claim and settlement responsibilities to the shoulders of an insurance company cannot afford to be without such a record.

**Accident Records for Guidance in Safety Work.**—Instead of relying upon "snap judgment," upon mere recollection of where accidents have previously occurred or upon fancied ability to predict where they will happen in the future, each industrial concern should be engaged in building up an accurate and comprehensive record of its own experience which in the end will constitute its most reliable guide to effective preventive work. The fact that no serious injuries have ever occurred on a plant and that any sort of injury is rare should not deter the manager from insisting on the collection of full information on even minor injuries and near-accidents, for it is often such plants that operate with a false sense of security, brought about by ignorance of their own operating hazards. It may also be said that just such plants are apt to suffer severely from lowered morale, uncovered losses and increased insurance rates when the unexpected accidents arrive.

**Relation to Production Efficiency and Cost.**—Accident records should show, not only how often injuries occur and with what severity, but on what machines or in what operations or stages of the manufacturing process. Even if the manufacturer is as yet unimpressed with the importance to him of accident prevention work, the information obtainable from such records may prove of real value in directing attention to those places in his plant where waste or other production losses are probably occurring, sometimes as the by-product of accidents, but more often as the result of operating inefficiencies which in themselves are capable of causing accidental injuries.

The cost of insurance is properly chargeable against cost of production, but neither it nor, in the case of the self-insurer, the cost of injury compensation and settlement is usually regarded as distributable over the different stages of the manufacturing process. No manufacturer, however, can afford to be without some knowledge of the relative burden that accidents may put on various operations or stages in his manufacturing process, for although his total workmen's compensation or employer's liability insurance premium may amount to but a fraction of 1% of the total payroll, the portion properly chargeable against a given shop, machine or operation may be equivalent to 5% or more of its own operating cost. Furthermore, there is the probability of additional incidental losses not covered by insurance, such as those caused by material ruined, equipment injured, interruption of production, demoralization, cost of accident investigation, employe replacement and similar indeterminable expenses, which may equal or considerably exceed the direct losses.

**Relation to Employment and Personnel.**—The records should be such as to permit a study of the relative frequency, severity and cost of injuries in various occupations and kinds of employment and among the different classes of employes, which may be of great value when determining a policy to be pursued in employing, assigning to work, transferring, promoting, discharging or retiring employes. Changes in general labor conditions as well as changes in process conditions within a plant always affect accident occurrence. In many occupations the inexperienced employe is injured more than twice as often as the experienced man and, where labor turnover is high, wage-rate increases or other changes calculated to reduce turnover may be justified solely by anticipated accident reductions. In other cases the desirability of changing the class of employes on certain jobs to those of another type or race may be indicated.

**Relation to Insurance and Legal Liability.**—The humane employer will be sincerely interested in preventing physical injury to his employes, regardless of the kind of insurance he carries. There are, nevertheless, economic questions to be considered. In many states occupational diseases do not fall within the scope of the compensation act and therefore are not covered by a workmen's compensation insurance policy. The employer is thus left liable to damage suits at common law, trial

by jury and heavy damages. He has also to face the possibility of claims for injury to general health arising from the occupation and sometimes becomes involved in a third party suit. In any or all such events the possession of adequate accident records may far offset the trouble and cost of maintaining them.

Where there is no compensation statute or where, for one reason or another, an industrial establishment is not within the scope of the act, the need for such records is even greater and full information on every injury case must be collected with the most meticulous care. The author recalls a war-time plant, operating in a non-compensation state and in a county where juries were notoriously ignorant and unsympathetic toward large employers, which made a practice of carefully photographing the scene of every accident and securing affidavits, not only from eyewitnesses, but also from bystanders who did not actually witness the accident but might be produced as eyewitnesses by the plaintiff. The value of these precautions was demonstrated many times. In one instance a carpenter entered suit for damages for injuries alleged to have been received by falling from an improperly constructed scaffold. The defense produced a dated photograph of the scene taken immediately after the supposed accident which showed the man's footprints in the snow to and from the scaffold but no marks made by a falling body. As counsel for the plaintiff could produce no eyewitnesses the suit was dismissed.

**Miscellaneous Uses.**—Not only does the employer receive occasional requests from other employers or trade organizations for information on his accident experience, but he is at times required to file such information with the state labor department or keep it available for examination by state inspectors. It may also be requested by insurance companies as the plant becomes eligible for experience rating and therein be of distinct monetary value in obtaining more favorable rates. On the other hand, if the employer is self-insured, it is essential for him to have reliable accident cost data on which to reckon his loss probability and the proper rate of set-aside to build up a sufficient reserve fund.

**Form of Records.**—A ledger entry is probably a satisfactory form of record for minor injuries on a large plant and for all injuries on a very small plant, but such records should show not only date, name of injured, position, time of injury, nature of injury, consignment of case, medical or surgical treatment and

date of redressings but also a complete account of the circumstances of the injury and the ascertained causes and assigned responsibility. If the services of an outside physician are employed, blanks should be furnished him for reporting complete information.

If a plant has over two or three lost-time injuries a year or is large enough to maintain its own hospital, part or full-time physician, or even a first-aid room, it is desirable that injury records be kept on forms or cards with which the physical examination record of the injured and the record of any other injuries or sickness may be conveniently filed, the whole constituting a complete physical history of the individual during his employment.

Whether the records are kept in a ledger, on cards or upon forms in a letter file, every injury requiring first-aid attention and every case of sickness developed at the plant or coming under the care of its foremen, nurses, first-aid men or doctors, should be made a matter of record. Copies of reports to state labor departments, insurance companies and others should also be preserved, as well as all other data pertaining to the accident or to the health history of the individual employe. Such records should be filed alphabetically according to the name of the injured or sick person, but it will also be found convenient to assign consecutive numbers to injury cases and file duplicate cards by cause of accident and by department or stage of process in which the accident occurred.

For a permanent record of what will be defined in the following chapter as "reportable injuries," printed forms are greatly to be preferred to entries or other memoranda on account of uniformity and insurance against omission of essential information otherwise left to the memory or imagination of the investigator. The larger employers, the state departments of labor and the insurance companies have their own forms, developed to meet their own requirements best, and no standard form can be recommended to meet all conditions.

As specimens, but not as examples of what such forms should be, those in use by the duPont Company have been reproduced in the Appendix. In (*A*) is shown the form on which injuries are reported by the plants to the main office. This contains the essential information secured immediately after the occurrence of the accident and serves as permanent record for both plant

and main office. It is abstracted on Injury Cards (*B*) and filed alphabetically, numerically for each plant and according to cause. (*C*) is the surgeon's preliminary report, (*D*) the surgeon's progress report and (*E*) the final disability report. The filing of the final personal injury report (*F*) marks the closing of the case. (*G*) is a form used by plant foremen.

This set of forms, more complicated than would be usually required, was developed for systematically handling the injury records of a large corporation operating 40 to 50 plants through a central office.

**Injury Report Forms.**—While certain formal questions must be answered in every injury report, those that pertain to the cause of the accident and the prevention of a recurrence are of special importance. While they will vary somewhat with each industry, three general inquiries which should always be satisfied are:

1. What was the injured's occupation immediately prior to the accident?
2. What was he doing when the accident occurred?
3. What was the nature of the accident?

The answers to these three questions should be clear statements derived from the explanation given by the injured himself (usually when reporting for treatment and preferably confirmed later), statements of eyewitnesses, statement of foreman (usually made on a report blank furnished for the purpose) and the investigation conducted by the safety engineer, safety committee or others. If the accident is formally discussed at a staff or safety committee meeting or by an "accident jury" the remarks should be taken down and made a matter of record.

Where accidents are the result of abnormal occurrences, and these may vary in degree from an upturned nail to a bursting flywheel, injury reports will generally be found fairly complete in detail and presenting an adequate picture of what took place; but when an accident has occurred in the course of normal operating procedure, particularly through some fault or negligence of the operator himself, the investigation is more often superficial and the report consequently lacking in information. If, as is usually the case, the personality or act of the injured man or his fellow employe was an important factor, the investigator should determine the effect, if any, of the following:

1. Grade of intelligence.
2. Skill.

3. Age and condition.
4. Prior instruction.
5. Length of employment.
6. Actual experience.
7. Familiarity with existing conditions.
8. Mental and physical condition at time.
9. Degree of supervision.
10. Influence of contributing conditions such as fatigue, light, heat, hurry, etc.
11. Use of personal protective appliances.

In the case of injuries caused while handling, transporting or fabricating materials or products in process or in the use of tools or process machinery, there are still other general questions that should be answered. In the first place, it should be clearly stated whether conditions immediately preceding the accident were normal, and if so, whether they were routine or at least customary, incidental, as in the case of oiling, adjustments and minor repairs, or distinctly abnormal, as, for example, during a breakdown or other emergency.

As regards the object causative or contributory to the accident, whether machine, tool, material or product, consideration should be given to questions relating to its

1. Selection for the purpose in view.
2. Inherent properties and hazards.
3. Condition at the time.
4. Manner of use or treatment.
5. Protection against dangers of use.

The author does not intend to convey the impression that such questions should necessarily be given a place on the printed accident report form but rather that they should occur to the mind of the astute investigator who desires to go deeply into the causes of each accidental injury regardless of its severity or of what may appear to be its obviousness. Indeed, it is often the most obvious accidents that merit the closest study.

# CHAPTER VIII

## INJURY STATISTICS

In addition to a knowledge of the circumstances and causes of individual accidents, there are two things requisite to intelligent direction of preventive work: a knowledge, as exact as is reasonably practicable, of the rate of injury occurrence in the plant or industrial establishment in question; and, for the purpose of comparison, at least a fair conception of the rate of injury occurrence on other plants engaged in similar lines of manufacture. Acquirement of the first presupposes the existence of adequate plant records, complete in detail and accurate in statement; the second assumes the existence of a source of information on the experience of others presented in a form to render comparison possible.

**National Statistics.**—"Adequate statistics of work injuries are of the highest value to the safety engineer, the insurance rate maker, the compensation administrator and the framers of legislation."[1] The truth of this statement is obvious but, while much progress has been made within the last few years toward general adoption of a national basis of computation, the objective of complete and comparable industrial accident records is yet a long way off—so far, in fact, that the industrial manager or safety engineer often finds himself unable to compare the records of his own plant with any other engaged in a similar line of production, and usually cannot ascertain the experience of his industry as a whole. The information that is available is often lacking in essential detail, as, for example, in explanation of the basis on which the rates have been calculated and the limits within which the figures are dependable. Sometimes, only statistics are available which cover an earlier period when industrial conditions, always a weighty factor, differed greatly from those now prevailing.

[1] DOWNEY, E. H., "Workmen's Compensation," The Macmillan Company, p. 76, 1924.

However discouraging this may be to the plant executive or safety engineer, let us hope that it may stimulate him to do everything in his power to encourage the accumulation of national statistics compiled on a uniform basis covering all common industries, and crystallize his determination to put forth the statistics of his own plant or company in a nationally comparable form. If the reader is a representative member of any of the national trade associations, in which this country is rich, let him by all means use his influence toward bringing about the collection of accident statistics in the industry which the association represents.

If this is to be accomplished, each industrial concern must, of course, be willing to abandon reticence on its own accident experience, be it good, bad or indifferent, and for the general welfare contribute it to the common fund. It should be remembered that no real advantage ever accrues from attempted concealment of the true state of industrial plant life and that an unwelcome amount of distorted press publicity and an unsavory reputation for maintaining an unsafe plant are more apt to be the growth of ignorance and exaggeration of actual conditions than of a clear and conscientious statement of conditions as they really exist. Many of our largest corporations have come of recent years to recognize the truth of this even when their field of endeavor has included the so-called hazardous occupations.

**National Basis.**—In 1917 the Committee on Statistics and Compensation Insurance Costs of the International Association of Industrial Accident Boards and Commissions submitted a plan for the derivation of uniform accident statistics which was adopted by the Association, and in 1918 the National Safety Council adopted the same plan as submitted to it by its Committee on Uniform Industrial Accident Statistics. It is this plan, first promulgated in the October, 1917, issue of the *Monthly Review* of the U. S. Bureau of Labor Statistics (Vol. V, No. 4), that is, with slight modifications suggested by practical experience, the basis of present-day accident statistics compiled on the "national basis." While by no means in universal use as yet, its adoption was a milestone on the road of concerted effort and it can at least be said that whatever its shortcomings, no better nor more comprehensive plan for compiling accident statistics has yet made its appearance. Every industrial concern should compile its statistics on this basis.

**Reportable Injuries.**—The primary division of injuries consists in the segregation of those which are *reportable.* This classification may be briefly explained by the statement that an injury which requires medical attention or merits first-aid treatment is reportable unless it is the result of other than fortuitous circumstances as, for example, when wilfully inflicted by another or when wilfully self-inflicted. Since any injury, no matter how slight, merits first-aid treatment, it is obvious that all true accidental injuries are reportable and should be made a matter of record.

**Tabulatable Injuries.**—The next important and sometimes difficult separation is into the classes of *tabulatable* and *non-tabulatable.* The definition of the term "tabulatable" as originally adopted reads: "all accidents, diseases, and injuries arising out of the employment and resulting in death, permanent disability or in the loss of time other than the remainder of the day, shift or turn on which the injury was incurred." This definition requires some further explanation.

It has been held legally in the interpretation of compensation acts that the term "accidents" may include both true injuries and occupational diseases, while the term "injuries" does not include diseases of occupation. On the other hand, there is a disposition to hold that injuries, to have been truly accidental (and tabulatable), must have had their inception at some fixed, though not necessarily ascertained time. This would exclude from the tabulatable class occupational diseases contracted from chronic exposure, as well as a large group of common physical ailments of occupational origin, such as strains, tenosynovitis and blisters, due to continued exertion or exposure, which are not, in surgical parlance, traumatic.

There is probably a great deal to be said in favor of any interpretation which will provide a fixed line of demarcation between cases which should be tabulated and those which should not, but it is clear that we ought assiduously to avoid definitions, a strict interpretation of which would relegate to an inconspicuous position cases for which industry was directly to blame. On the whole, then, the author is inclined to disfavor the adoption of too rigid a definition of the term "tabulatable" and to urge instead that every fortuitous injury and disease of occupational origin, or which has been materially aggravated by occupational

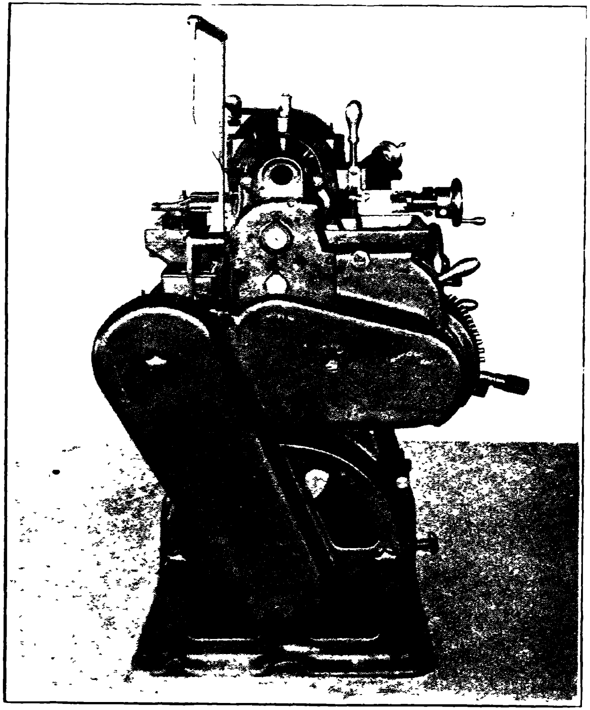

**Plate** VIIa.—Guarding of a Modern Lathe. (*National Safety Council.*)

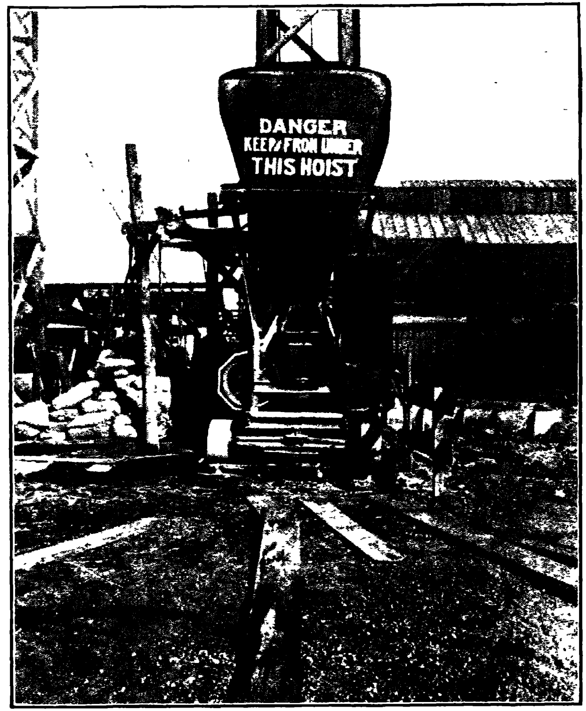


**Plate** VIIb.—Protection of Cement Mixer—(note gear guards, warning sign and fence). (*E. I. duPont de Nemours and Company.*)

(*Facing page 74*)

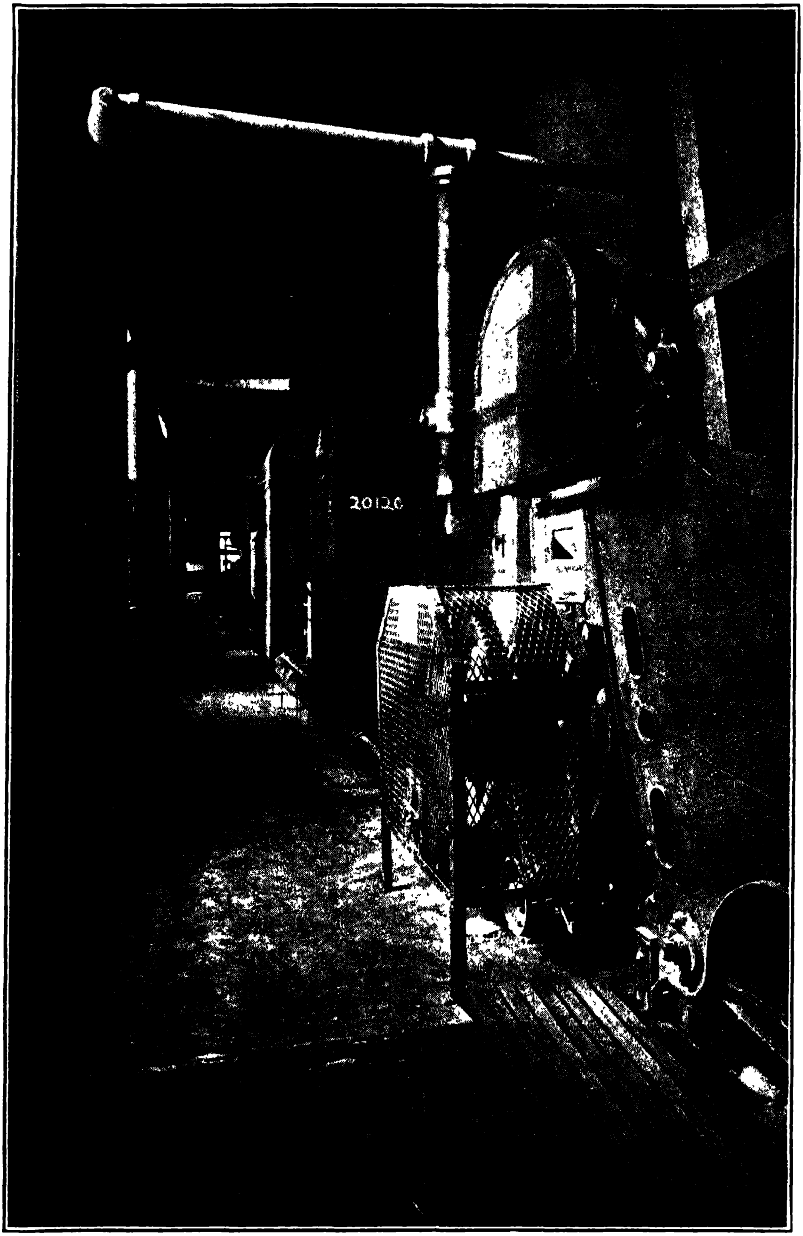


PLATE VIII.—Safe Passageway in a Dry-room. (*E. I. duPont de Nemours and Company.*)

(*Facing page 75*)

conditions, be considered tabulatable provided it meets all other requirements.

The question of what injuries may be properly said to arise out of the employment is certainly an important one. Compensation act phraseology is somewhat varied and has sometimes been construed to exclude injuries occurring in transit to or from work. Since, however, the national definition of a tabulatable injury omits the words "and in the course of employment," it would seem reasonable to include as tabulatable all injuries incurred on plant premises during transit to or from work, during the lunch hour or at other times when work is not actually going on.

The author is of the opinion that the tabulatable class should not be rigidly confined to those injuries which ordinarily pertain to the immediate employment or to the industry in question but should include those which are the result of industrial conditions in general. Notwithstanding this more liberal interpretation, however, ordinary communicable diseases, common sickness and other ailments of internal origin not associated with occupational conditions should not be classed as tabulatable injuries even if contracted at the place of employment or aggravated by working conditions. On the other hand, if they follow in the train of an accident or as the indirect result of an injury, they should be considered as prolonging the period of injury disability. Thus, an infection following a mere scratch or ether-pneumonia following an operation performed on account of an injury, contribute to the injury disability, even though the infection may have been picked up outside the plant and the pneumonia be the result of surgical neglect.

The definition states, "loss of time other than the remainder of the day, shift or turn on which the injury was incurred," but in practice this has been construed to mean loss of *working* time. It therefore ignores the intervention of Sundays and holidays. This introduces no serious discrepancy but the intervention of a shutdown is another matter. No ruling has appeared to cover this. In the author's opinion it is a matter of judgment and fairness: If the employe would not have been physically able to return to work on the following day, had the plant operated on that day, the case should be considered tabulatable.

The discrepancies created by these minor lapses are probably negligible beside those due to variations in what has been aptly termed "medical inadvisability to work." In some cases the injured is returned to work as soon as possible by the interested plant physician, urged on perhaps by the safety engineer or a representative of the employes' benefit association—returned even before he is physically able completely to perform his regular duties. In other cases, the more leisurely procedure of the private practitioner or the public hospital permits his return only when he himself feels entirely recovered. This affects not only the length of disability from work but, in less serious cases, their inclusion in the tabulatable class. More will be said on this subject in Chap. XIX.

If a less-than-tabulatable injury "lights up" at some later date, causing additional loss of time from work (other than the balance of the working day or shift), it is, of course, reclassified as tabulatable and entered as of the date of the original injury as a "reopened case."

All reportable permanent disability injuries are tabulatable and all reportable deaths from accident should be, although under strict interpretation of the national plan death must have ensued within 30 days of the accident. The author, however, is inclined to take issue with this and recommend that *all* delayed deaths be included (provided they were brought about through the occurrence of a reportable injury) and entered as of the date of the original injury or occupational disease.

**Basis of Rates.**—Of course it is necessary to select a common basis for the derivation of injury rates in order to permit comparison between rates on the same plant, with rates of other plants and with the rates of the industry as a whole. The usual and "national" basis is *exposure*. It is expressed as "hours exposure" or "man-hours worked." This is not usually the equivalent of payroll hours since the latter is apt to include considerable time paid for but not worked, as in the case of overtime, temporary disability compensation and leave-of-absence on account of sickness or military duty.

If possible, man-hours should be an actual count of hours worked from clock or time cards. Computations based on the number of names on payroll, estimated average hours worked per day or estimated average wage rate will almost certainly be unreliable.

The figure for man-hours should include those of foremen and others normally exposed to operating hazards, even if paid on a daily, weekly or monthly rate. In any event, the injuries which are used in computing the frequency and severity rates must have exactly the same "spread," not only as regards classes of employes but also in respect to the period covered, as the man-hours used as basis for the rates.

In the beginning, the unit of the national basis for rates was not the man-hour but the "average employe," the latter being, not a mere payroll name, but a derivation from payroll hours made on the assumption of 300 10-hour working days per year. This unit was not entirely satisfactory, and the fact that the calculated figures for "average number of employes" was, on most plants, materially less than the true average caused confusion and misunderstanding. The present unit of man-hour is much to be preferred.[1]

**Frequency Rate.**—This is the number of tabulatable injuries per million man-hours worked. It varies from 5.0 or less in exceptionally safe industries and well-managed plants to 100 or more under unsafe conditions. In large establishments or groups it is also customary to compute separate frequency rates for fatalities, permanent disability injuries and temporary disability injuries. The definition of permanent disability is that given in the compensation statute of the state in which the plant is located.

As stated in Chap. I, fatality frequency rates are frequently expressed as deaths per thousand employed. When so expressed, it should be clearly stated whether the base is derived from man-hours or is the number of names on payroll.

**Severity Rate.**—This is the total number of working days lost as the result of tabulatable injuries per 1,000 man-hours worked. The number of working days lost in the case of temporary disability injuries is the actual, and includes the day of injury occurrence. Days actually lost on account of permanent disability and fatal injuries, however, are not included and *weighting* is used instead. These weights, shown in Table VII, were derived by the committee of the International Association

[1] For more detailed information on this and other subjects discussed in this chapter the reader should consult "Standardization of Industrial Accident Statistics," *Bull.* 276, U. S. Bur. Labor Statistics, Government Printing Office, Washington, 1920.

of Industrial Accident Boards and Commissions and represent, not average disability from work on account of injury, but the estimated loss of economic usefulness expressed in terms of working days.

TABLE VII.—TABLE OF TIME LOSSES FOR WEIGHTING INDUSTRIAL ACCIDENT DISABILITIES TO SHOW SEVERITY

| Nature of injury | Degree of disability in % of permanent total disability | Weights in days |
|---|---|---|
| Death | 100 | 6,000 |
| Permanent total disability | 100 | 6,000 |
| Arm above elbow, dismemberment | 75 | 4,500 |
| Arm at or below elbow, dismemberment | 60 | 3,600 |
| Hand, dismemberment | 50 | 3,000 |
| Thumb, any permanent disability of | 10 | 600 |
| Any one finger, any permanent disability of | 5 | 300 |
| Two fingers, any permanent disability of | 12½ | 750 |
| Three fingers, any permanent disability of | 20 | 1,200 |
| Four fingers, any permanent disability of | 30 | 1,800 |
| Thumb and one finger, any permanent disability of | 20 | 1,200 |
| Thumb and two fingers, any permanent disability of | 25 | 1,500 |
| Thumb and three fingers, any permanent disability of | 33⅓ | 2,000 |
| Thumb and four fingers, any permanent disability of | 40 | 2,400 |
| Leg above knee, dismemberment | 75 | 4,500 |
| Leg at or below knee, dismemberment | 50 | 3,000 |
| Foot, dismemberment | 40 | 2,400 |
| Great toe, or any two or more toes, any permanent disability of | 5 | 300 |
| One toe, other than great toe, any permanent disability of | 0 | 0 |
| One eye, loss of sight | 30 | 1,800 |
| Both eyes, loss of sight | 100 | 6,000 |
| One ear, loss of hearing | 10 | 600 |
| Both ears, loss of hearing | 50 | 3,000 |

In applying these weights, injuries not involving amputation should be assigned a proportion of the weight stipulated for the entire loss of the member in accordance with the degree of impair-

ment. The weighting for impairment of function of any member should be such percentage of the weighting for dismemberment as may be determined by the adjudicating authority in fixing the compensation for such impairment, *i.e.*, if loss of an arm is compensated by 240 weeks' indemnity, then an impairment of the arm for which 160 weeks' compensation was paid should rate as two-thirds of the loss of the arm in the above scale. Hernia should be included only as a temporary disability on the basis of the actual time lost.

The use of weighting in computing severity rates has met with considerable objection from those who have felt that the heavy weights specified for death and serious permanent disability dominated and tended to obscure that part of the severity which was contributed by the relatively large number of temporary disability cases. They have pointed out that a fatal termination, or even permanent total disablement, is largely a chance outcome not always influenced by conditions surrounding the accident. Yet those who have employed this method of computing severity rates claim to be well satisfied with it and it seems to be in a fair way toward national acceptance.

The severity rate is, essentially, merely a weighted frequency rate. If there are valid objections to its use, as some claim, the defect probably lies in the table of weights rather than in the principle. The values of all the present weights were based upon the adoption of 6,000 days' weight for death cases. In selecting the latter figure the committee's report explains:

> Working life expectancy is a function of mortality and superannuation; it is less than life expectancy by the interval between voluntary or enforced retirement from gainful employment and death. It is well known, however, that the life expectancy of our industrial population is markedly below that experienced by life insurance companies, while the evidence of accident statistics, as well as common knowledge, goes to show that relatively few wage workers maintain a footing in industry beyond the age of 55. On the whole, it seems reasonable to assume that working life expectancy, between ages 20 and 50, is about two-thirds of the full life expectancy shown by the American Experience Table. The compensation experience of a number of states indicates that the average age of persons fatally injured by industrial accidents is approximately 33 years. Your committee, accordingly, adopted 20 years, or 6,000 working days, as the average severity weight of fatal accidents.[1]

[1] *Loc. cit.*, p. 766.

In the author's opinion there is some question on the propriety of penalizing industry for the entire estimated working-day life expectancy of deceased employes. Probably supporting data are lacking but it seems reasonable to suppose that few payroll employes work 300 days a year continuously for 20 years between the ages of 33 and 53. Ethelbert Stewart, U. S. Commissioner of Labor Statistics has stated:

> A study of the payroll data in the manufacturing industries, which employ 11,000,000 of our population, indicates that the fluctuation in volume of employment alone spells an average total of 12 months' unemployment for from 1,500,000 to 1,750,000 of that total number. Of course, I do not mean that this number of individuals are out of work for 12 months, but the average aggregate of idleness or the low percentage of full employment in various industries amounts to about 1,750,000 persons being idle all the time. This waste is spread, of course, over the entire 11,000,000 employes.
>
> Sad to say, this does not take account of such short periods of idleness as 2 or 3 days, nor does it include the individual loss of time due to sickness, much of which is preventable, nor the enormous loss of time due to industrial accidents, most of which are preventable; nor does it take into account the turnover.
>
> A low estimate of average turnover for industry as a whole is 30% which means that probably 3,500,000 men change jobs an average of once a year. The average loss of time between job and job is 2 weeks. Most of this 7,000,000 weeks of lost time is unnecessary and a pure wastage of men. Of course, a very large percentage of those who go to make the turnover change jobs two, three, four and sometimes ten times a year. This reduces the number of actual individuals involved but does not change the situation as to the industrial waste.[1]

Some further light is thrown on the situation by the results of an exceedingly careful study of employment conducted by the National Bureau of Economic Research[2] which seems to indicate that the average employed individual is not gainfully employed much more than five-sixths of the time. Also Stuart Chase in his recent book, "The Tragedy of Waste" estimates the idle man-power on a given working day at 6,000,000 or 15% of the 40,000,000 able-bodied adult population.[3]

[1] "Wastage of Men," *Monthly Labor Rev.*, U. S. Bur. Labor Statistics, **19,** 1, p. 3, 1924.

[2] KING, W. I., "Employment Hours and Earnings in Prosperity and Depression," Nat. Bur. Economic Research, New York, 1923.

[3] The Macmillan Company, New York, pp. 143 and 270, 1925.

If the average man in industry works 250 days a year instead of 300, it seems somewhat unfair to penalize industry on account of a fatal accident with 1,000 days which would not have been worked had the victim survived. A reduction of 15 to 16⅔% in the weights for permanent disability and death would certainly bring the temporary disability cases into greater prominence and perhaps satisfy some of the critics of the present severity rates. Nevertheless, the author has no intention of recommending that the reader tamper with the present table—its use should be adopted nationally subject to future changes covered by national, not individual, endorsement.

**Rates Based on Production.**—One occasionally sees rates formulated on the number, severity or cost of injuries per unit of plant or process production. While usually not useful for national comparison, such rates may be of real value to an individual plant or to a group of similar plants, mines, etc., the output of which can be measured in standard and more or less constant units.

Although from the humanitarian veiwpoint the proper basis for injury rates is undoubtedly exposure to injury, it must be remembered that industry's primary function is to produce and not merely provide employment for industrial workers. If, therefore, it is able to promote production by introducing methods or equipment which at the same time decrease human exposure to injury, the credit due it should be reflected in the injury rates. This may not happen to any marked degree when the rates are based solely on exposure. Let us take as example the case of a plant which formerly moved certain castings on hand trucks but later made changes to permit handling them by electric crane. Assuming that man-hours consumed in the operation were thus reduced one-half, the frequency and severity rates *based on man-hours* might show no change but even an increase. The fact is, however, that exposure to accident would have been halved and this lessening of the aggregate hazard would be reflected in frequency and severity rates *based on production.*

Rates based on production have a real value in intraplant competitions and where work is largely repetitive as, for example, in punch press shops. They should, however, be used with circumspection, bearing in mind that the production on which they are based fluctuates under the influence of factors unaffected by accident hazards.

**Injury Cost Rates.**—In comparing injury costs the amount of payroll is generally used as basis, the rate being expressed as cost per $100 of payroll. While subject to fluctuation with changes in compensation provisions and though not strictly comparable with similar rates in states having different compensation provisions, such rates have at least the advantage of being less affected by fluctuation in wage rates than any other measures of accident reduction based on costs. They are, however, not as reliable an index of accident prevention conditions as frequency and severity rates, although they are always of interest to executives.

In presenting them it should be clearly stated whether the costs represent actual expenditures or are in reality the accrued liability from accidents which occurred in the given period. In most respects the latter figures are to be preferred, being less subject to distortion from fluctuations in the employment. Their use, however, requires the insertion of estimates for future expenditures in unclosed or reopened cases, including those in process of litigation. If the employer is self-insured and his policy in settlement and relief is a liberal one, the final cost of injuries for a given period may be 30% or more above the figure compiled at the end of the period—at least, such has been the author's experience.

**Days without Accident.**—The number of days (working or calendar) without a tabulatable injury is computed for psychological rather than statistical purposes. Because of its simplicity it is probably the only form of mathematical statement that can be readily comprehended by all payroll employes. More importance, however, is today being attached to the value of no-accident rates as an inverse measure of accident frequency than was formerly the case. When a large plant has reduced its accidents to the point where only one or two take place every year, the number of days without a tabulatable injury is as informing as the frequency rate and of vastly greater value for purposes of publicity.

**Minor Injury Rates.**—While it is desirable to compute the frequency rate of less-than-tabulatable injuries, it should be borne in mind that a high frequency rate for this class of injury may be a good rather than a bad sign, indicating that cases are actually being reported for first-aid treatment. Minor injury frequency rates may be useful also as a means of checking the work of plants that are striving to set up a no-accident record or

are pitted against each other in some form of safety contest. If a plant is able to exhibit a consistently declining minor injury frequency rate as well as a consistently declining tabulatable injury frequency rate (and it is certain that minor cases are reported for treatment), it is probably the result of improved safety work, but if the minor rate rises as the major rate falls it may indicate an overzealous effort to minimize the seriousness of injuries.

For the purpose of securing a better check on the results of accident prevention work the duPont Company divides the less-than-tabulatable into two classes, *submajor* and *minor*. It classifies as submajor those cases in which the injured returned to work on or before the following working day, but suffered a temporary loss of working efficiency and had to be put on lighter work, relieved of some of his duties, given a helper or had his work interrupted by constant visits to the hospital or doctor. In view of the constant and generally praiseworthy efforts to get injured men back to work at the very earliest moment permitted by the doctor, this special classification was considered desirable and the filing of a weekly summary of such cases on blanks prepared for the purpose was required. The submajor frequency rate serves as an excellent check on the major frequency rate and is not disturbed by fluctuations in the minor frequency rate caused by better reporting to the hospital.

**Cause Classification.**—Aside from its value in letting in the light on the more dangerous portions of the manufacturing or operating process, statistical data arranged according to cause permit comparing at least some part of a plant's accident experience with that of other dissimilar plants or industries. This is so because all industries have in common certain fundamental hazards.

It is probable that each separate plant or industry will find it advisable to develop a cause classification best suited to its own needs, but the general and very complete list in *Bulletin* 276 of the U. S. Bureau of Labor Statistics (Government Printing Office) may be used as basis, omitting such subclassifications as do not apply and adding any others that may be needed to cover conditions special to the industry. Statistical analysis on the basis of cause should not be confined to frequency of injury alone but should include severity and possibly cost.

**Practical Considerations.**—Every industrial establishment, regardless of size, should compute yearly its frequency rate,

severity rate, cost of injuries (accrued liability) per $100 of payroll and best no-accident record. These rates should cover exactly the same tabulatable injuries, in other words, all those that have occurred during the calendar year, disability or cost for unclosed cases being estimated and included pending receipt for actual figures. Each year the rates for the preceding year should be checked for the inclusion of final items previously estimated or not included.

It is also usually desirable to compute similar rates for tabulatable *and* non-tabulatable injuries, the latter constituting a legitimate charge against operations.

The extent to which additional or more frequent computations should be made depends largely on the "spread," that is, the size of the establishment. If more than a few tabulatable injuries have occurred during the period, it is desirable to break down the annual frequency rate into separate frequency rates for fatal, permanent total disability, permanent partial disability and temporary disability injuries and to compute separate rates for the various divisions or departments of the plant. For very large plants a monthly computation of rates is useful and, for plants of medium size, quarterly rates. In either case it is desirable to display these beside the rate for the year to date (cumulative rate) and the rate for the preceding year. If the business or the hazards are subject to seasonal variation it is often an advantage to show a comparison with the same month (or quarter) of the preceding year.

Throughout, it must be borne in mind that for relatively small exposures or short periods the rates, especially the severity rate, are subject to violent fluctuations. Under such conditions the general trend of the rates is more important than actual values and the engineer should be exceedingly circumspect in arriving at conclusions that may later prove to be premature. The plotting of comparative curves will often illuminate the situation and obviate faulty deductions that might be drawn from the tabulated figures alone.

In *Bulletin* 276, of U. S. Bureau of Labor Statistics and *Safe Practices Pamphlet* 21, of the National Safety Council, Chicago, 1924, will be found recommended forms for statistical records and statements. Other forms and statements will suggest themselves to the safety engineer as his familiarity with the local situation and the requirements of his work increases.

## CHAPTER IX

## PRELIMINARY ORGANIZATION

In preceding chapters it has been intimated that the safety organization should initiate and stimulate safety work but, that, as development proceeds, its execution should be taken over by the regular operating organization. This is essential if safety is to become a directing force in the attitude of every employe toward this work and in no other possible way can an industrial plant be made safe in the sense that accidental injuries of all kinds are eliminated for long periods. The safety organization, therefore, has as its main purpose not so much the prevention of accidents as the concentration of the entire plant on accident prevention.

**Stages of Development.**—In the course of accident prevention work in an industrial plant which has never before undertaken to organize for safety, we may recognize three stages in the development of an effective safety organization:

1. The *initiatory stage*, wherein the safety organization, in addition to initiating certain fundamental work, such as the establishment of injury records and the guarding of the more obvious mechanical hazards, must awaken the interest of all employes.

2. The *educational stage*, in which the most important function of the safety organization is that of maintaining the interest it has awakened and converting it from mere passive acceptance of the safety idea into active participation in the work.

3. The *constructive stage*, reached only when the operating officials, having themselves become active in safety, can be relied upon to see to the continuance of active participation by the employes under their immediate control, thus relieving the safety organization of much of the detail of the educational effort and permitting it to turn its attention to the correction of hazards at their source. In this stage, safety has become part of the duties of every man, in that it exerts a directional influence on the performance of his work and there has been created on the plant what,

for want of a better name, we may term "safety atmosphere," the influence of which is felt by everyone, even the newest employe.

Naturally, no clear line of demarcation may be drawn between these stages for they overlap and merge, but they have existed or will exist in every industrial plant before it achieves long no-accident records. If we do not recognize them we will experience difficulty in selecting the best methods for reaching the desired ends and may fail to perceive the causes of non-success.

**Behavior of Injury Rates.**—The course of the frequency rate curve of plants maintaining a safety organization is generally downward, but as the work progresses the decline becomes gradually less rapid, the curve tending to flatten out parallel to the *x-axis* of the chart. The decline of the severity rate is usually less marked; sometimes the curve is quite flat and sometimes shows an inclination to rise as the frequency rate falls. One may interpret this characteristic behavior of the rates to mean that the less serious injuries are more readily preventable, and that with each succeeding year the work of further accident reduction grows more difficult.

The dominant factor in the severity rate is the weighting for permanent disability and death. In the majority of these cases the chief causes of accident are what have been styled "inherent hazards," meaning thereby the natural actions and reactions of forces and materials encountered in industry. To illustrate the effect this has on the rates, we may select as example injuries incurred as result of stumbling through mere awkwardness.

Ordinarily, stumbling would mean no injury or but a slight one, yet if the resultant fall carried the stumbler over the edge of a high scaffold, into revolving machinery, against the cutting edge of a machine tool or into a tank of acid or caustic, the injury would be serious. With the first application of the safety idea two effects would be noted: Operators would be more careful not to stumble, and some of the places that were conspicuously hazardous would be protected. This would naturally decrease the number of minor and major injuries and decrease both frequency and severity rates. There would remain, however, many places more difficult to protect, such as the open edges of platforms used for egress or for hoisting materials, remote parts of revolving machinery where employes were not expected to go, the points

of application of the cutting edge of machine or woodworking tools to the material being worked upon, places at the edge of or above open tanks where employes would have to stand for one purpose or another.

The difficulty encountered in protecting such places might arise from improper choice, design or arrangement of equipment, inaccessibility, real or fancied interference with operations, difficulty in maintaining protection or its high first cost. Furthermore, the comparative infrequency of the more severe accidents would also exert an influence tending to make both employer and employe minimize the hazard, even if they were conscious of its existence.

Whatever the causes, it is certain that there would be "points of resistance" at which the application of effective protection was delayed and where a stumbling employe would still be in imminent danger. At such places serious injuries as result of stumbling would probably continue to occur with almost the same frequency and severity as before the inception of the safety movement.

There is also another element that intrudes on the situation, namely, the new employe. While the men who have been employed for some time have become entirely familiar with their surroundings, have learned to recognize most of the unprotected hazards and have been persuaded to exercise some degree of care, the entirely new employe commences work with none of these advantages. He may or may not be shown the danger points and his attitude toward them may be far from what it ought to be. His technique, such as it is, may be faulty. In a word, he is likely to be injured by the very hazards that the more experienced employes avoid.

The citation of an example at his point may not be amiss. A plant employing 330 men had a number of obvious hazards which should have been guarded but were not. One of them was a narrow walkway along the edge of open tanks containing hot liquids. Men were required to wheel barrows loaded with solid materials along this walkway and dump them into tanks. There were no railings on either side and considerable care was necessary, especially in negotiating the turns at the corners. The plant management thought that railings would be in the way. Through an intense educational and organizational effort the plant succeeded in accomplishing a run of 724 consecutive working

days without an injury, a very remarkable record in view of the conditions that existed. This record was broken, however, when a *new employe* allowed his foot to slip off the walkway into a tank as he wheeled a barrow around a turn. Before protective railings were installed a second and similar accident occurred to another new employe! This was followed by a *third accident* which resulted fatally under very similar conditions.

**Adapting the Organization to the Situation.**—We have used an accident such as the above merely as a convenient illustration; the principle involved is of general application. So long as severe hazards remain unguarded, the severity rate will not show a decrease corresponding to the decrease in frequency rate. As the plant's safety organization becomes established, the importance of rectifying these conditions will become increasingly evident and the safety organization must be capable of formulating intelligent and effective recommendations, often relating to major changes in equipment or operating methods. This calls for a higher order of accident prevention work—for safety engineering. A safety organization which has proved its value as a stimulative and educational agency may be almost totally ineffective when this stage is reached.

In the immediate past a vast number and variety of safety organizational methods have been given publicity, but there seems to have been no clear recognition of the importance of fitting the method to the situation or of altering it as conditions change. It is true that safety organizations are constantly being changed, but the changes are not infrequently born of a desire to try something new and, especially, to adopt "stunts" that some other plant has found efficacious when applied to its own conditions. There is often no real attempt to analyze the specific demands of the immediate situation and work out an appropriate remedy. The results are consequently chaotic—sometimes temporary success, sometimes disappointment, and often serene unconsciousness of much wasted effort. Doubtless, a large part of this comes of failure to recognize that the nature of the demand is in process of constant alteration as development advances.

What has been said in the foregoing is especially true of safety education and, in fact, of education in any form. In industrial accident prevention there are, of course, no clearly defined first, second and third periods of safety development such as described

in a preceding paragraph, but rather a gradual transition through these stages; similarly, in the development of a child's mind there are no defined stages corresponding to the grades of a public school, yet our school teachers would hardly be so shortsighted as to apply the same educational material and methods to age 12 as to age 7. Yet this is almost precisely what one sees done in teaching safety to industrial operatives. From failure to discern the needs of advancing stages of safety development, payroll employes who have had 5 years or more of safety schooling are often fed entrance grade material which they have very naturally outgrown and will mentally reject. It is not surprising that many of them have by this process come to look upon the industrial safety movement as childish and its teachings as mere tiresome repetition.

**First Steps in Organization—Leadership.**—In Chap. I we noted the value of leadership and its effect on the accident experience of the iron and steel industry, the mines and the railroads. Each industrial establishment must have leadership in its accident prevention work and, above all, intelligent, farsighted leadership.

While the plant manager is nominally the rightful leader in any new undertaking and, as explained in a preceding chapter, must continually exhibit his personal interest in accident prevention, he should not assume the burden of the active direction of safety work in addition to those other duties which he alone is fitted to carry out.[1] A leader of recognized standing is, nevertheless, essential and he should be an operating official, preferably the assistant plant manager or at least one of the manager's immediate assistants.

An operating official is desirable for this post in order that the effort may be recognized as a distinct part or aspect of operating procedure and not as merely corollary to it. The selection of an official of relatively high rank not only gives the work dignity at the outset but makes possible prompt decision on important matters without necessity of appeal to the plant manager. It is obvious, furthermore, that work which is later to become a

[1] A possible exception exists in the case of very small plants employing, let us say, less than 50 men, where the manager's immediate assistants may be little more than foremen and therefore not particularly fitted for undertaking work which is not only entirely new to them but of a sort requiring considerable imagination and no small amount of initiative.

definite part of every operative's duties should be supervised by one of the operating officials. This same official should also have general supervision over first aid and medical work, compensation and relief, and fire prevention since these subjects are closely related to accident prevention. By such arrangement any possible conflict with these allied subjects is avoided. If the same official has supervision over employment and general welfare, so much the better.

The selection of the individual who is to be the executive head (*supervisory* but not *technical advisory*) of the safety work is a matter of no little importance. It is not necessary that he should have had any prior experience in accident prevention, but it is absolutely essential that he know his plant and be esteemed by his fellow officers and by the men. To select for this post a man who is unpopular, impatient, bigoted, impracticable or an extremist is to handicap the movement at the very start. What is needed is a broad-minded, mature, sympathetic man with all the qualities of leadership. While it will usually be found that such a man can assimilate the safety work without detriment to his other duties, he should not be required to overstress himself to do it, otherwise the quality of his work will necessarily suffer. If he is to act as leader by virtue of his position as chairman of the works safety committee, he may be relieved after the work is well established and a successor appointed, but it is recommended that no change be made during the first 6 months at least, and thereafter not oftener than every 6 months. Frequent changes in leadership may benefit the individuals selected for the post, but the effect on the work as a whole is apt to be detrimental.

After the plant manager has selected the leader he should impress on him the following points:

1. That he is being given supervisory control over accident prevention work and is accountable to him for results.

2. That the work is at least equal in importance to his other duties and in case of doubt must be given priority.

3. That he is expected to supervise the work directly and take an active part in it but must at the same time see that others do their part. For this reason he is carefully to avoid doing work which is properly a function of others.

4. That he is given authority to authorize expenditures not exceeding a stipulated amount.

. 5. That results must be got through education, inspiration and cooperative action rather than by exercise of executive authority. Failing this, controversies are to be referred to the manager for hearing and decision.

**Technical Assistance.**—The selection of one of the manager's immediate assistants to head the safety work almost assures the requisite of leadership, but it by no means assures the amount of technical skill or eventual accident prevention experience required for even a medium-size plant. It would be inappropriate for the assistant manager of a large plant to devote sufficient time to master the details of safety engineering, keep abreast of its present rapid development and perform many minor duties in connection with safety work which could be done as well by a less highly paid employe. Therefore, to obtain the advantages of technical skill, single-mindedness in handling a somewhat difficult class of work and the zeal of an enthusiast, it is customary to employ for such work a man who is variously known as "safety engineer," "safety supervisor," "safety inspector" or sometimes merely "safety man." To such a man are often assigned kindred matters, such as first aid, fire protection, compensation and general welfare, especially on plants employing from 50 to 200 men where the full time of one man on safety work alone cannot be justified, and in this case his title is usually "superintendent," "director" or "supervisor" of safety and welfare, or merely "service supervisor." The particular title and the exact field of work covered varies in different plants but we shall usually refer to this position as that of "safety engineer" on the assumption that one of his duties is the prevention of accidents.

**Supervisory and Advisory Leadership.**—The recommended set-up for a medium-size or large plant, therefore, is that of a production executive as leader who has general supervision over safety work and a safety engineer who is his technical advisor and under his nominal control. How will such an arrangement conform to the changing requirements of the accident prevention situation?

In the initiatory stage the safety engineer's ability in assembling statistical support for the movement will be brought into play as well as his recognition of obvious hazards and his experience in guarding them. He will be the main source of enthusiasm and will be doing important work by "selling safety" to the leader-

executive. The latter, on his part, will be taking the first steps to introduce safety to the operating organization.

In the second or educational stage the organization of safety committees, described in subsequent chapters, will have been set up. The safety engineer will serve and stimulate them constantly. He will be called upon for a greater amount of technical advice but must still concentrate his efforts largely on inspirational and educational work. The leader-executive is now directing the work so that the superintendents, supervisors and foremen are beginning to assume personal responsibility for accident prevention in their respective departments. To this end he is constantly watching to see that what is developed by the safety committees is adopted by the operating organization and becomes incorporated into its operating procedure.

By the time the third stage has been reached frequency and severity rates are on their downward course. The plant and its separate departments are striving for no-accident records. Safety is a live topic, housekeeping has shown real improvement and a marked change has come over the entire plant. The time is now ripe for fundamental changes in process and equipment which will result in fewer serious accidents and better production, for improvements that will extirpate the old hazards—not merely guard them in a way that can never be entirely proof against unsafe practices. It is now that the engineering skill and judgment of the safety engineer is brought into play. It must be tempered, however, by the more mature operating experience of the leader-executive. The latter has at his command two essential contacts: direct access to all operating heads by virtue of his executive relation to them; and the ear of the plant manager who must authorize or at least approve the expenditures that are necessary for major changes. By reason of his supervisory control of safety work during its early stages the leader-executive has become its staunch proponent and he is now in logical position to bring about the acceptance and authorization of important work that is necessary before the plant can be made fundamentally safe.

For a well-balanced organization capable of carrying through to the third stage the combination of an executive supervisory leader and a technical advisory assistant (who is in many ways a real leader) seems to be necessary. In plants employing less than 100 men, however, the justification for a safety man is

difficult to prove and probably depends largely on the condition of the plant, character of its work and its previous accident record. On larger plants experience indicates that a safety engineer of the right caliber justifies his employment not only through savings resulting from fewer accidents but also by relieving more highly paid operating officials of detail work that would otherwise have to be performed by them.

The safety engineer should be a high-grade man, well paid and perhaps competent to function in executive capacity, but his real value is as an enthusiast, educator and technician and his duties, other than those pertaining to the supervision of such assistants as he may have, should be kept within the advisory field. There is, indeed, a real danger in permitting the safety engineer gradually to take on responsibilities which belong properly to others.

Because the selection and training of the safety engineer is a matter of great importance to the success of the accident prevention work, the subject is given more detailed consideration in the following chapter.

# CHAPTER X

## THE SAFETY ENGINEER

While not, in an executive sense, the leader in safety work—or, at least, not properly so—the safety engineer is, or should be, the technical inspirational leader. It is largely within his power to make or mar the local movement; consequently, his selection, his training and the opportunities afforded him of becoming more proficient in his work are of no slight importance.

As the problems to be solved will be essentially different in each separate plant a safety engineer who has been successful in one situation may fail ingloriously in the next. Added to this is the element of changing conditions affecting all plants and requiring the safety engineer to alter his methods to meet the demands of the moment or perhaps fail from lack of versatility, flexibility or a ready perception of the needs of the situation.

While it would be impossible to describe the type of man who would be successful in any given case, general requirements may be laid down which the safety engineer should be capable of fulfilling.

**General Qualifications.**—The safety engineer, in the first place, must have had not only interest in the subject but an actual inclination to take up the work. The average individual, once involved in safety work, tends to become absorbed in it to a degree that is often incomprehensible to even his immediate friends; in the argot, "he gets the safety bug." The actual appeal is doubtless to one of the fundamental human instincts, essentially altruistic and opposed to the selfish and more animal instinct of self-preservation. Evidence of the universality of this appeal is furnished by the intensity of interest exhibited in meetings where accident prevention is intelligently discussed, for example, the Annual Safety Congress of the National Safety Council, and by the great diversity of persons attracted and held by the safety movement. But, as would be expected, there are those to whom the saving of life and prevention of needless suffering mean nothing in the abstract and very little

in the concrete. That such persons should not be inducted into active work of this sort is quite obvious.

On the other hand, it is not necessary that the prospective safety engineer should incline toward sentimentality on the subject of human life-saving. If he is temperamentally soft he will be of little use in an emergency and probably of no use in situations where "backbone" is needed. He should be both human and humane, warm hearted and subject to generous rather than selfish impulses. Men who are "hard" by nature, or as result of experience, are not good material and have little interest in safeguarding those who would otherwise suffer through their own perversity or stupidity. To feel that accident victims get only "what is coming to them" aptly expresses the feelings of the individual who is "hard," but such a feeling tends to inhibit the conduct of successful accident prevention work, for safety must be administered with a sympathetic rather than censorious touch.

H. W. Forster, Vice-president of the Independence Bureau writes:

> The most important qualification of the safety engineer is enthusiasm. Of course, he must have in safety work, as in every other field of endeavor, certain basic qualifications. He must be physically well, honest and industrious. He needs good intelligence and a sufficiently general experience to enable him to see his problems clearly and work out the solutions. He is greatly benefited by technical training, by specific experience in the industry in which he furthers safety, and by personal experience with the men with whom he must work, but even though theoretically ideally qualified, if he does not possess enthusiasm, he never will be a real success. Safety is a gospel to which each worker must be converted. Safety must be preached with conviction and almost religious fervor. It must be preached and practiced day by day, month by month, year after year. A man must believe or he carries no conviction. He must break through resistance to new ideas, through resentment against interference with existing working conditions, through suspected infringement of personal rights. No man will ever succeed in the long run in accomplishing the best results without a compelling, contagious enthusiasm.[1]

In a previous chapter some mention was made of the necessity of frankness and sincerity of purpose and this is as essential in the safety engineer as in the executive. In the game of prevent-

[1] Personal correspondence.

ing accidents no one bluffs continually and successfully and the man who plays it selfishly or untruthfully soon has his measure taken. Every opportunity to deal frankly and squarely with the payroll men must be taken advantage of if one is to overcome their natural prejudices, suspicions and astuteness in discovering hidden reasons for new policies and self-seeking motives behind welfare plans.

The safety engineer must possess initiative and be to a reasonable degree aggressive, though unintelligent aggressiveness is certainly no asset. Too often one encounters safety enthusiasts who are so vigorously and tactlessly aggressive, so prolific in stunts and schemes, so vociferous in their demands for "safety first" that they do as much harm as good. They hold their audiences for a certain time but make few permanent converts. The sincerity of these individuals is beyond question, but their judgment is faulty.

Patience is essential—patience with slow, erring, stubborn human nature. At least one-half the educational task lying before the safety engineer is in overcoming prejudice, breaking up old habits and establishing a new scale of values; at least one-half the remainder consists in substituting active effort for mere passive acceptance of an idea. It is an undertaking of formidable proportions since it has to do, not with the plastic minds of children, but with the crystallized habits of adults, the great mass of whom are ignorant or unintelligent, intolerant of coercion and, through labor turnover, subject to constant change. This great mass does not come to work to be taught but primarily to earn money, and its principal interests lie elsewhere. Even the educated man, although he readily accepts the safety idea, does not put it into immediate and unfailing practice, and from the great mass of payroll workers we must expect far less. Their natural resistance can only be broken down little by little. In this great task, subject to many setbacks and many distressing failures, often made heartrending by the resultant loss and misery, the engineer who lacked patience and human sympathy would soon grow despondent. In patience, sympathy and perseverance lies the only chance of success.

Because so much of his contact will be with the foreman and men the safety engineer ought to be what is called "a good mixer." This cannot be realized if he is insincere, unsympathetic, untruthful, self-centered or conceited. Nor will he prove

agreeable company if he makes accident prevention his only thought in life and his sole topic of conversation. If the man possesses good balance and judgment and is not unsophisticated this matter will usually take care of itself.

Ability to judge men is an important quality but equally important is ability to judge conditions. By this is meant not only good sense in estimating the relative value of conditions (sense of perspective) but also keenness of eye and intellect to detect dangerous situations. This latter quality enables a man to become a good inspector. Coupled with the "inspective" and perspective faculty should be at least a fair memory and sufficient imagination to enable him to deduce the possibility of accidents which have not yet occurred. If he is also endowed with a sense of humor he will be helped over many hard places.

**Education.**—There are many "safety men" who had less than high school education and many safety engineers who have never seen the inside of a school of engineering. Some of these are skilful and efficient, but the safety man of the smaller plant ought to have had the benefit of high school education at least and the safety engineer of the larger plant, if he is really to be an engineer, must have had engineering training of some sort. Without it he will certainly find himself seriously handicapped.

To fill the position properly in even a small plant the man should be able to compose a clear and concise report of what he has seen and give an equally clear and concise verbal statement. This may seem too elementary to be worth mentioning and yet one frequently encounters safety men who seem unable to deliver anything but a rambling, garbled account of their observations and others who can neither read a blueprint nor prepare a lucid sketch.

The candidates for the more important positions should have had some experience in public speaking or at least be capable of delivering a clear, straightforward talk at meetings of payroll men or plant executives.

**Experience.**—Considering the newness of the safety movement and the more or less haphazard way in which it has found its place in the industrial picture it is not surprising that there is a dearth of experienced safety engineers seeking employment. For this condition industry itself is largely to blame since it has been too ready to employ or promote men who lacked the essentials of temperament and training and too reluctant to pay

salaries sufficiently large to attract men from other employment. Industrial executives, as a rule, have been reasonably well satisfied with any individual who was prolific in new ideas and expressive on the safety subject, provided he did not also create trouble, that is, interfere with normal production. Most industrial executives have seemingly failed to recognize that they were facing in the industrial accident situation a problem of no mean proportions which would in the end require, for satisfactory solution, professional training and a high order of technique.

But few steps have been taken as yet by educational institutions toward developing engineers capable of coping with the industrial safety problem. A few technical schools and colleges pay some slight attention to the subject but none as yet recognizes safety engineering as a profession for which young men should be trained. There is really no place to which a graduate engineer can have recourse for schooling in it; it has never been made the subject of fundamental research; it has never been endowed. There have been, it is true, a number of scattered, localized and generally unassociated educational efforts of which the most effective have been brought about through the efforts of the National Safety Council, but industry as a whole has neither recognized the scope and intricacy of its problem nor discerned the need of securing trained men to solve it.

The importance of technical training for engineers, chemists and professional men generally is by this time thoroughly appreciated, but in the field of accident prevention the opinion that only common sense is needed still prevails. It is a matter of general knowledge that, while the country was losing 70,000 men in 19 months' participation in the World War, 126,000 persons were being killed by accidents at home. Immense sums are spent to reduce the extent of war-time casualties and men are carefully trained to this end, but the industrial decimation from accidents goes on all the time without provoking horror and public condemnation and without stimulating the education of accident prevention specialists. It is indeed a situation that needs correction. As civilization advances man becomes more merciful and attaches a higher value to human life. Industry probably will in time remedy the present deficiency, and with an increased demand for experienced safety engineers will interest itself in their training. At present, however, the demand is light, the supply is scarce and the sources are restricted.

**Training.**—Since most industrial concerns must, to a greater or less extent, train their safety engineers, some discussion of this part of the subject is not amiss. Experience is doubtless the best teacher but such experience should be broad and not confined solely to the plant in question. The safety engineer should be encouraged to mix with other safety engineers and visit other industrial establishments. He should be required to avail himself of the benefits of membership in the National Safety Council and should attend the Annual Safety Congresses and local safety meetings and interest himself in the kindred subjects of public, school and home safety. There should be no parsimony in authorizing the purchase of textbooks or other material that he may desire and he should be consistently encouraged to keep abreast of progress in his profession. Two facts should never be lost sight of: that he is to a certain degree a pioneer in a new profession; and that his efficiency in a difficult field is very largely dependent on maintaining his interest and enthusiasm.

If the safety engineer handles accident prevention only, his interest in the allied subjects of compensation, relief, sanitation, health, first aid, fire protection, employment and general welfare should be encouraged. It is necessary for him to cooperate with those in charge of such matters. If he himself is in charge of any or all of them he should be accorded the same opportunity to perfect himself in them as in the safety work. It is not to be expected that he will become equally proficient in each or that all will interest him to the same extent. If, however, he has the qualities necessary to a good safety man he will probably become proficient in his handling of the other subjects, since accident prevention is the broadest and, in many ways, the most difficult of them all.[1]

**Salary.**—The salaries of experienced "safety men" or safety engineers appear to vary from about $2,400 to $10,000 per year or higher. The higher salaries are commanded by trained men, many of whom in addition to safety work cover the entire industrial relations field of large corporations. Naturally the salary is also dependent on the size of the corporation, its policies, the responsibilities of the position, experience, age, length of service and actual accomplishments of the individual.

[1] A valuable contribution on the qualifications and training of safety engineers is to be found in Fred G. Lange's recent "Handbook of Safety and Accident Prevention," p. 11 *et seq.*, The Engineering Magazine Co., 1926.

All else being equal, the safety engineer's salary should not be less than those of production and service executives with whom he is expected to cooperate on equal footing, otherwise he will function at a decided disadvantage.

S. F. Shattuck, Treasurer of the Kimberly-Clark Company, says:

> Officers of the company, should treat their safety director, in meeting and out of meeting, on the same plane with their responsible department heads. In all meetings of department heads, safety records and safety planning should meet on a level with the planning for any other phase of the operation.[1]

To affect this properly there should be no great disparity in salaries.

**Promotion.**—Within the small company there is often but little opportunity for promotion to a higher position in the same line of work except through accession to the supervision of other and allied functions. This constitutes one of the obstacles to securing suitable men for safety engineering work and holding them indefinitely. The only possible way around appears to be through salary increases without actual promotion to positions of greater responsibility. While this may seem to the employer to upset his prevailing salary scale, it can usually be reconciled on the basis of the higher salaries demanded by technical experts. In any event, every reasonable effort should be made to retain the services of a satisfactory safety engineer not only because of the great dearth of such men but since he is, if efficient, in a position to save his employer an amount of money considerably in excess of his salary.

[1] "Management Responsibility," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, I, p. 731, 1925.

# CHAPTER XI

## SAFETY COMMITTEES—PURPOSE AND STRUCTURE

It would be difficult to determine where and when the first safety committee was established, but it is without doubt one of the oldest components of the safety organization. The Committee on Safety of the United States Steel Corporation was appointed in 1908 and a general form of committee organization for subsidiary companies was adopted at the same time. By 1912 the Chicago and Northwestern Railroad, under the able leadership of the late Ralph C. Richards, had completely organized its system in safety committees. The safety committee plan of organization has therefore persisted for at least 17 years. That it is to be found in some form in almost all plants where accident prevention work is firmly established is an indication that it fulfills a purpose and has more than passing value.

**Purpose of Early Safety Committees.**—The pioneers in accident prevention soon discovered that mechanical safeguarding alone would not prevent injuries and that safe men were of as much if not more importance than safe machines. In order to get safe men it was obvious that all the men must be induced to take an active part in safety work. Boyd Fisher declares.

> The safety movement did not begin to have any effect in reducing accidents until safety engineers learned to give more attention to committee organization than to mechanical safeguards. When they discovered that they could corral the impulses and interests and energies of the workers by means of putting them to work upon each other, they began to achieve exhilarating success.[1]

Aside from the value of safety committee organization in creating individual interest in accident prevention, there were obvious advantages to be gained in other ways. For years factory conditions had been becoming constantly worse and, until the advent of workable compensation laws in 1911, means of redress for injuries incurred during employment were uncertain and unsatisfactory. Labor had other and justifiable griev-

[1] "Mental Causes of Accidents," Houghton Mifflin Co., p. 152, 1922.

ances against its employers and there existed a state of industrial unrest, not only in this country but in England and Germany as well. The safety movement introduced into this situation was a new thought to the mind of the worker and, following so closely the enactment of workmen's compensation laws, was looked upon with some suspicion. To the employer, committee representation presented a possible way in which these suspicions could be allayed. It provided at the same time a means by which the intimate knowledge of actual working conditions that the working man possessed could be put to practical use. Safety committees composed wholly or partly of payroll men were the result and they are said to have been the first instances in the history of industrial relations in which employer and employe met to discuss amicably the administration of the industrial establishment for the common good.

The safety movement has now become so well established in this country and knowledge of it has spread so far that, no matter what the opinion of the individual operative may be, labor as a whole has ceased to regard it with suspicion. Nevertheless, the organization of safety committees can be justified on this score alone, when the employer is introducing safety work for the first time or is operating plants with labor that is raw, shifting or to a great extent foreign born. In well-established plants with low labor turnover, and especially where relations between employer and employes are cordial, there is obviously less need to have safety committees perform this function, though their organization is justified for other purposes.

Another function of the safety committee was to permit the training of the individual member in the proper mental attitude towards accident prevention. It was felt that during his term of service on the committee he would not only be brought into close contact with other men who had already given the subject mature thought but would be practically constrained to think about it himself. In order to extend this training to as many men as possible, the term of service was usually made brief and the make-up of the committee was changed gradually by dropping a member and adding a new one. In this way it was hoped to have every man eventually serve at least once.

There is some question as to the validity of this latter plan. In most plants, it would be impracticable to have over 10% of the men serving on committees at the same time, and, with a

minimum length of service of 1 month, the rate at which men were being trained might be considerably less than the rate of labor turnover. In particular, the plan could not be relied upon to furnish the necessary training for the newer men—the very class that needs it most—however efficacious it might prove for the more stable men including, of course, the foremen.

On the other hand, safety committees did and still do provide a satisfactory means of training selected individuals, among them those known to be indifferent, stubborn or reckless, by bringing them under the influence of other steadier or more enlightened members of the committee. Many anecdotes might be related of the conversion of the more perverse to the ways of safety but it must suffice to say that there is no more certain and painless method than through service on a safety committee.

Still another purpose of committees was the detection of unsafe conditions and practices which might escape the eye of the management. There seems to have been a feeling that service on a safety committee would somehow open the eyes of its members to hazards which they did not observe in the course of their daily work and that discussion of them would lead forthwith to apt and intelligent suggestions for their remedy. In the earlier days of accident prevention, when there were neither adequate standards of protection nor the sources of information that exist today, safety committees probably functioned to great advantage in this direction, but conditions have materially changed and new ideas for making safe the operations are now more readily and more efficiently obtained from safety engineers, inspectors or organizations such as the insurance companies and the National Safety Council.

Examination of the reports of workmen's safety committees will usually reveal a great number of recommendations pertaining to simple and recognized hazards, such as defective ladders, broken railings, defective stairs, floors or platforms, unguarded openings, non-use of appliances such as goggles and respirators, unprotected transmission machinery and misplaced or defective guards. In the earlier days of the safety movement, before such conditions had become commonly recognized hazards and before the foremen could be educated in the primary principles of accident prevention, it was perhaps natural that they should have been left to a safety committee to detect and have remedied. Of late years, however, the situation has changed

and any foreman who today permits such hazards to exist undetected in his department and needs a safety committee to point them out to him is deficient and, in theory, at least, does not merit a foreman's position and pay. If he is deficient in his protection of life it is possible that he is deficient in other lines as well. He has, or ought to have, a better knowledge of operating conditions in his department than any other man on the plant; he has been told that accident prevention is one of his duties; if he fails so to function, the management should correct him or, failing in the effort, replace him.

**General Purpose and Structure of Safety Committee Organization.**—In the initiatory and educational stages of the safety movement in a given plant, the primary purpose of a committee organization is inspiration and education. It serves to give keymen an opportunity for direct participation in a general effort to prevent accidents. In this way it is essentially a means of raising the standard of mental attitude of the individual towards accidents and, continued, eventually standardizes the mental attitude of the plant on a new and higher level. To accomplish this purpose in the best possible way the committees should be changed as fast as their members become thoroughly imbued with the safety idea. They should, furthermore, be given every opportunity to advance in self-education. Correction of unsafe working conditions is, for the moment, of secondary importance, although it will naturally be accorded primary importance in the minds of the members. The committees must be supplied with full information on the causes of accidents in the plant and in similar industries and should be encouraged to undertake *committee inspection* and *committee discussion* rather than independent action as individuals.

As the constructive stage of safety work is reached, the primary purpose of committee organization changes somewhat. Standardization of mental attitude towards safety becomes of decreasing importance, and the correction of fundamental defects in working conditions, in the working organization and in the individual as a component part of the organization demands the committee's attention. This change, however, is not registered in all parts of the committee organization simultaneously and may never manifest itself in committees composed solely of payroll men. When and where it does occur it marks a distinct advance into the region of more successful accident prevention. At such a

time it is probably less important to change the personnel of the committees frequently than it is to retain on them those individuals who contribute most effectively to the work in hand; in fact, standing committees may be found desirable.

The purposes of a safety committee organization are inspirational, educational and advisory rather than functional. It can be efficient so long as it confines its attention to matters which may be handled more effectively by a small body of men collectively than by the same or other men individually. It should never be permitted to preempt functions or assume responsibilities that belong properly to the operating organization, since by so doing it militates against the principle of making safety part of every man's work.

**Definition of Terms.**—The usual structure of an industrial safety committee organization consists of a "works safety committee" composed of the higher operating officials and other committees serving the various departments, shops or other logical divisions of the establishment. Sometimes we encounter an organization molded on functional lines employing "foremen's safety committees" and "workmen's safety committees." Very small plants have, as a rule, but one safety committee of mixed membership of payroll men, foremen and even officials. Corporations operating a number of plants often have a "central safety committee" in addition to the usual plant safety organizations.

In order to avoid confusion we shall employ the terms "central safety committee," "works safety committee" and "departmental safety committee," including in the latter all committees made up of payroll men or payroll men and foremen, regardless of the territory covered by them.

**Structure of Works Safety Committee.**—The most important safety committee in the industrial plant is the works safety committee. In the case of an isolated plant removed from the headquarters of the corporation this committee should consist of from five to seven men ranking not lower than heads of departments or their first assistants, with the safety engineer serving as secretary. The chairman should be a high ranking official, preferably the assistant manager or the general superintendent of production, if there is such an officer. The chairman should be the leader-executive mentioned in Chap. IX. Except, perhaps, on very small plants it is not advantageous to have the plant manager

himself serve in this capacity. It is far better he should act as a court of appeals on matters wherein the works safety committee fails to reach agreement or is unable to get the operating heads into line. As there are working foremen and supervisory foremen, so are there working managers and supervisory managers, but it will be generally conceded that the plant manager who does not regularly take an active part in plant activities but watches and holds himself in reserve for the "breaks of the game" gets better results in the end.

It is exceedingly important that the safety engineer should *not* be chairman of the committee. He is not in the line of the production organization and to place him in the position of functional head of the safety work leads away from, rather than toward, the purpose of having accident prevention become a definite part of the work of the production organization. As stated in Chap. IX, he should be the inspirational leader as well as the source of technical information on accident prevention and, as such, act as technical advisor to the committee, as its liaison officer and as follow-up man on all the details of its work. His position as secretary permits this but at the same time acts to control any natural temptation to assume executive authority for the sake of getting safety work done.

If sympathetic and endowed with the right personality, the assistant plant manager is usually the best choice for chairman. He is in position to assume a reasonable degree of responsibility for the adoption of policies and for the authorization of expenditures, has ready access to the manager himself and yet is not in position to overawe, intimidate or dominate the committee.

The majority of members of the committee should be production men, but it is well to include the plant doctor if employed on full time, a maintenance man or engineer and a chemist, if major chemical operations are involved. Every effort should be made to set up a well-balanced committee with no single element predominating. The first committee should be selected with extreme care as it will probably set the pace for those that are to follow. The choice of members should therefore be made with an eye to securing harmonious and sympathetic action rather than broad representation. Later on, service on the committee may be employed to bring the unsympathetic or reactionary members of the staff into line or to accelerate action in departments of the plant in which there is lack of interest,

but it will be wise to postpone such efforts until the movement has been established.

The chairman of the committee may be permanent or may be changed from time to time—there are advantages to be gained through either course—but the author recommends a permanent chairman believing that more uniform and consistent results will be accomplished thereby. Except the secretary, who is a permanent member, the remainder of the committee should serve not less than 3 months or more than 1 year and it is probably advantageous to change one or two at a time rather than the entire body. The frequency of change will be governed to a great extent by the size of the plant, the number of men of high rank available for service on the committee and the stage of the work.

At first, meetings of the committee should be held weekly, but, after the work has become more or less established, biweekly meetings will usually be found sufficient with perhaps an occasional special meeting to discuss a serious accident. Short and frequent meetings are better than long meetings held once a month, for the interest of the members must be sustained and the work of the committee must keep pace with plant changes and with the accident situation.

It may be pertinent at this point to meet the objection raised by some plant managers that the service of so many of their immediate staff on a committee which meets weekly, or even biweekly, will seriously interfere with their regular work. The author discussed this point with a number of plant managers who have had long experience with works safety committees. The consensus of opinion was that service on the committees appeared to expedite or improve the regular work of the individual members so that interference did not actually materialize. This, of course, holds true only so long as the committee confines itself to work that it is best fitted to perform; if it is allowed to wander off into discussion of mere detail it can obviously waste much valuable time. This is apt to happen in organizations in which no departmental safety committees have been appointed.

The foregoing committee structure applies to separate plants isolated from the main offices of the corporation. If the corporation operates but one plant and has its offices on or close to the plant property, some slight modification may be desirable as, for example, the addition to the committee of a legal advisor or claim agent and perhaps one of the vice-presidents or some

other officer of the corporation. On the other hand, if the plant is isolated and only a small one—less than 50 men—the committee organization may have to be scaled down to meet existing limitations. Below 25 men employed, the equivalent of a works safety committee is difficult to arrange and is probably not justified.

In a large corporation operating a number of plants under centralized control not only should each plant have its works safety committee but there should be at headquarters a central safety committee of still higher caliber of which the corporation's safety engineer is executive secretary. While such a superorganization might not seem justified at first glance, it offers unlimited possibilities for coordinating, strengthening and standardizing the safety work carried on by the separate plants and is the most facile medium through which to maintain interest, secure appropriations for major changes, bring about the adoption of basic safety principles, offset the tendency to curtail safety work during periods of business depression and facilitate the careful scrutiny of new lines of manufacture and new manufacturing policies. Without such a coordinating committee, the rate of progress on separate plants is apt to vary considerably.

**Structure of Departmental Safety Committee.**—Only in very small plants is a single safety committee able to cover the entire field of safety education and accident prevention, and on a medium-size or large plant, where the works safety committee is composed of highly paid and important men, it is plainly inadvisable to require it to give time to details of the less important parts of the work. Furthermore, a single committee does not provide opportunity for educating a sufficiently large part of the personnel through direct service.

It is customary, therefore, to appoint departmental, area or shop safety committees. While these are sometimes made subcommittees of the works safety committee, a far better plan is to make them independent of it and of each other, the committees serving in advisory capacity the functional heads of their respective departments, areas or shops. As such, the activities of each committee are usually confined to its own department, area or shop.

The number of committees needed is, of course, governed by the size and character of the plant and its departmental or geographical subdivisions. There should not be less than two or three

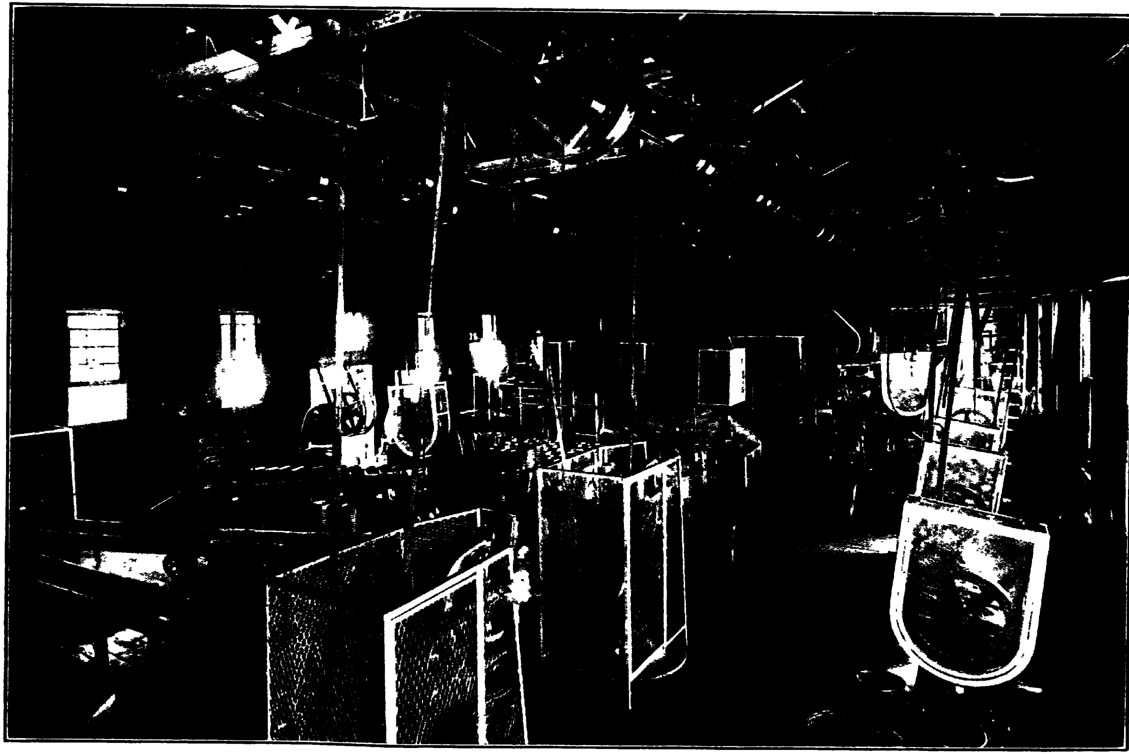

Plate IX.—Protection of Machines in an Old-time Shop. (*E. I. duPont de Nemours and Company.*)

(*Facing page 108*)


Plate X.—Platforms and Walkways at a Tank-car Unloading Station. (*E. I. duPont de Nemours and Company.*)

(*Facing page 109*)

such committees; it is usually convenient to have one for each functional group of 50 to 100 men. As, however, this part of the safety organization should embrace all crafts and all divisions of the plant including offices, laboratories, warehouses and storerooms, railroad and freight yards, yard gangs, repairmen, riggers, construction forces, shops and power houses, it is often necessary to appoint committees to represent somewhat smaller units or else combine several such units in a group represented by a single committee. If the plant operates more than one shift, it is also desirable to have separate committees for each shift.

The number of men on each committee should be governed somewhat by the size of the department or group represented, but it should not be less than three or more than seven. A committee of three is usually able to function satisfactorily although the recommendations of a committee of four or five are better balanced and entitled to more respect. The members should not be above the grade of foreman and while there is much to be said in favor of mixed committees composed of men drawn from all ranks the best service is generally obtained from rather homogeneous committees made up of subforemen, "straw bosses," mechanics and higher grade operatives. Perhaps the best plan is to start with the higher grade men, and, as these complete their term of service, introduce men of the lower grades.

If meetings are held as often as they should be, 3 or 4 months is a reasonable term of service. Members should serve in rotation in order to avoid changing the texture of the committee too abruptly; for example, with a committee of three serving 3 months, the oldest member should go out and a new member come in each month. With this arrangement, reasonable continuity of effort is possible without having a permanent chairman, the member having the longest service acting as chairman until his term expires. As a rule, no permanent secretary is necessary provided the committee is accorded stenographic facilities for preparing its reports.

All committees will, of course, either be allowed time to perform their duties during working hours or be paid for the necessary extra time. The former method is preferable. It is also desirable that each member be given a badge or button at the beginning of his term and be required to display it continuously. When his term has expired he should be urged to continue his interest and assist the movement unofficially.

# CHAPTER XII

## SAFETY COMMITTEES—FUNCTIONS

In the preceding chapter the structure of the safety committee organization is set forth—typical rather than definitive, since the conditions to be met on different plants and in different industries vary enormously, although it may be pointed out that the basic principles of organization remain the same; so also with the functions of a works safety committee and subordinate committees—we may only cite what appears to be typical, realizing that modifications must be made to suit local conditions.

**Functions of Works Safety Committee.**—Although having qualitatively no more executive authority than is vested in its individual members by virtue of their repective positions, this committee acting in advisory capacity to the manager not only heads up the local safety movement but is able to bring about the adoption of its recommendations by department heads. In undertaking to do this, however, its action should be advisory rather than mandatory and it should appeal to the manager for executive action only when every effort to win over cpposition has failed. It functions also as a general clearing house for safety ideas and suggestions and determines the course of the safety movement in the plant.

The committee will receive from its secretary at each meeting a report on injuries that have occurred. Such reports should include complete statements by the head of the department in which the injury occurred together with the results of the investigation made by him or his men. (A typical report will be found in the Appendix.) These should be supplemented by the secretary's statement of his personal findings in the cases. Both statements should deal specifically with:

1. Cause of accident and injury.
2. Preventive measures.
3. Responsibility.
4. Discipline recommended.

These will be carefully discussed and if not clear, or if lacking in detail, will be referred back to the department head or secre-

tary, as the case may be, for further details, or the responsible parties may be called in to make further explanation. In serious accidents it is desirable, both for the moral effect and for a better knowledge of conditions, that the committee visit the scene of the accident.

When all the facts are in hand it is the duty of the committee to reach a final decision on cause and prevention of the accidents and then to take the necessary steps to have the remedies put into effect. It must also finally determine the responsibility. If discipline is involved, after reviewing any existing safety rules, it should consider whether the penalty recommended by the department head is just and reasonable, not only on the merits of the case but in its relation to previous penalties and to its moral effect on the plant personnel. If it disagrees with the department head in any of his recommendations, the committee should call him in to discuss the question. Failing to arrive at mutual agreement, the matter, if of sufficient importance, may be referred to the manager for final decision.

One of the weaknesses of so-called "workmen's safety committees" is their inability to concentrate on unsafe practices and exercise sufficient imagination to foresee the consequences of conditions that are complicated or obscure. Consequently, their inspections are largely given over to the detection of hazardous conditions which are more or less obvious. The works safety committee, on the other hand, through its careful scrutiny and discussion of injuries deals very largely with safe and unsafe practices and, because the minds of its members are better trained for analysis and deductive reasoning, it is able to go further toward the elimination of hazards at the source as against the mere protection of men from hazards. Its constant attention to matters of responsibility and discipline, moreover, will cause it to survey continuously the safety rules of the plant and the degree of observance. After the safety movement is once established the works committee should concentrate on these subjects for the negotiation of which it is particularly well adapted. An interesting letter of instructions to safety committees will be found in the Appendix.

Periodically the committee should make a check inspection of the entire plant. To facilitate this the plant may be divided into the same number of areas as there are members and an area assigned to each for inspection. As far as practicable no member

should be required to inspect an area over which he has operating jurisdiction. Such inspections should stress operating practice and methods, condition of structures and fixed and movable equipment, housekeeping and general conditions, handling of materials, repairs and construction, lighting and ventilation and, in general, those broader and deeper phases of the work which are apt to be beyond the ability of departmental safety committees. Members, however, should not report lists of minor defects and hazards except to illustrate a prevalent condition. Such matters should be referred to the department head and by him to his assistants and foremen. The correction of these details should be followed up by the departmental safety committee and by the safety engineer rather than by the works safety committee.

The works safety committee should maintain interest in the work of the departmental committees, occasionally sending a delegate to their meetings, but at the same time it should carefully avoid any suggestion of control. Subjects referred by it to these committees should be routed through the respective department heads, the safety engineer acting as liaison officer.

In addition to work in connection with current injuries and prevailing operating conditions there are many subjects which may be profitably discussed by the works safety committee, such as:

General plant or foremen's safety rallies.

Safety bulletin boards and publicity on plant accidents.

Questionnaires and other means of securing the interest of the men.

Plant no-accident contests and celebration of no-accident records.

Competition between areas or departments.

Special accident drives, such as "Ladder Days," "Tool Inspection Days."

Periodic inspections of elevators, chains and ropes, cranes, electrical appliances and other special equipment.

Reporting of minor injuries for treatment.

Getting injured men back to work.

Employment, physical examination, placement, instruction and training of new men.

Transfer and retirement of older men.

Special safety rules.

Awards for safety suggestions.

Many other subjects will present themselves from time to time as the safety work progresses.

Minutes of the meetings should be briefed, typed and circulated among the heads of departments. Examples of safety committee minutes will be found in the Appendix. The chairman should also report at the regular meeting of the manager's staff. It is desirable that once a year the entire work of the committee be reviewed by the manager with a view to directing the course of future work into the most productive channels, and from time to time he should attend the meetings in order to demonstrate his personal interest.

**Functions of Departmental Committees.**—The functions of a departmental committee are somewhat similar to those of the larger committee scaled down, however, in proportion to the area covered and the ability of its individual members. It is very desirable that it investigate all reportable injuries occurring in its department and scrutinize the records of even minor injuries. It should be encouraged to determine cause, recommend preventive measures and place responsibility, leaving the matter of discipline, however, to the department head. If its findings are not concurred in by him or eventually by the works committee the reasons should be carefully explained, otherwise the individual members will soon lose interest; so also as regards recommendations made by it for physical changes which have been refused.

Departmental committees should make inspections covering all portions of their department at least biweekly. Weekly inspections are usually desirable but, if the department is spread over considerable territory, it may be necessary to zone it for the committee, arranging to have one zone inspected by the entire committee each week. The author believes this to be a better plan than apportioning the zones to individual members as has been recommended for check inspections by the works committee. The members of a departmental committee are not, as a rule, to be relied upon as independent thinkers and usually have not had the same opportunity of becoming familiar with the operating plant as have the members of the works committee. It will be better, therefore, to have them go over the ground as a committee and not as individuals. No one need apprehend, however, that the recommendations of safety committees made up of men of the grade of foreman or below will be

so unsound as to be embarrassing to the management; experience has shown that the recommendations which have to be rejected for good and sufficient reasons are always surprisingly few. Inspection by the committee as a whole will tend to raise the general level of the work, educate, promote better feeling among the members and conserve individual suggestions of merit which might otherwise be rejected.

Of course, every facility for performing their work should be extended to the committees, and they should be required to cover every nook and cranny of their departments, questioning whomever they wish but not interfering with the work or subrogating the authority of the foremen. They should also check up on the progress of work resulting from their previous recommendations.

The greater part of the time given to committee work should be expended upon inspection and subsequent discussion. It is a mistake, however, to assume that individuals, merely by being assigned to a safety committee, will become satisfactory inspectors overnight. They must be encouraged and, as far as practicable, trained. The effort is worth while, for psychologically there is presented at this time a wonderful opportunity to advance their knowledge and eventually make of them useful safety men. With this in mind, the committee should be supplied with safety literature, such as descriptions of accidents, safety bulletins, safety standards and periodicals devoted to accident prevention, such as the *National Safety News*.

The maintenance of department safety bulletin boards and no-accident score boards may be placed in the hands of the departmental committees. They should also be urged to attend all plant safety rallies and any public safety meetings held outside the plant, and in other ways avail themselves of opportunity to learn more about the safety movement.

While usually not necessary to record the minutes of departmental committee meetings, the recommendations should be typed, and sent to the department head. As soon as possible, thereafter, he should meet personally with the committee, or at least with its chairman, discuss the recommendations, explain frankly his reasons for rejecting any of them and state what action he intends to take on the others. Such action will serve to assure the committee that its efforts are appreciated and are considered worth while even though some of its recommendations have not met with favor and others have not been

acted upon promptly. The time so spent by the department head will be well repaid and the result will be in most cases a functioning committee rather than a weak and almost useless appendage to the operating organization. To prevent its becoming atrophied the department head must *use* his committee.

**Future Committee Development.**—The comparative newness of the safety movement, the necessity of creating a different point of view on accident occurrence and the need of a positive driving force to overcome the ascendancy that industrial hazards have already obtained are the excuses for the establishment of a committee form of safety organization. Up to this time no other type of organization has proved equally effective, or effective under so many and varied industrial conditions. That safety committees are necessary in the majority of plants and that they are capable of producing wonderful results cannot be questioned. The author, however, is inclined to believe that safety committees will have no permanent place in the industrial organization of the distant future unless they become merged in a committee form of production organization, the general adoption of which seems at this time highly improbable.

Even though departmental safety committees are not allowed to function as subcommittees of the works safety committee, the safety committee organization to some extent parallels the operating organization and in so doing tends to defeat the very purpose for which it is created—to make safety a part of the regular duties and responsibility of every employe, salaried and payroll. This somewhat anomalous position is justified in the early stages of the movement by what it accomplishes in inspiration and education and later by what it effects in what may be termed "practical research;" the latter at least, in so far as the works committee is concerned. Beyond this stage we are as yet unable to forecast the future, but it seems quite possible that the works committee may be supplanted by meetings of the manager's staff giving, for the moment, its entire attention to accident prevention. In fact, to the writer's knowledge, such a transition has already occurred in more than one plant.

With respect to departmental and shop committees it may be pointed out that the exercise of their chief function, inspection and the detection of common hazards, is properly the duty of the foremen and should be made so as fast as the hazards become recognized as such. When the national attitude toward accident

occurrence has been corrected and when some satisfactory system of training the new employe has been adopted by industry, the educational advantages of the departmental safety committee may disappear.

It is interesting to note in passing that at least one large corporation, which has for years been doing successful accident prevention, has entirely abandoned its committee form of organization and is carrying out safety work through the operating organization.

As the committee form of safety organization will undoubtedly persist for many years to come, we are justified in pointing out that it has been found equally effective as a medium for handling special operating and personnel problems, not necessarily associated with accident prevention, which are encountered in every plant. Fire prevention, health hazards, physical examination, placement and training, compensation and relief, insurance and general welfare are matters which naturally suggest themselves as proper subjects for consideration by a works committee, but subsequent, rather than prior, to the firm establishment of the safety movement.

# CHAPTER XIII

## INITIATING THE MOVEMENT

Addressing ourselves now to the executives of an industrial plant or corporation which has never undertaken organized accident prevention work, we may begin with the statement that the safety movement should be fittingly and impressively launched if full advantage is to be taken of the golden opportunity that occurs but once in the life of any industrial plant. The situation demands some prior knowledge of the subject, considerable forethought and a carefully worked out plan. Without such preparations the effort will lag and falter in its early stages, employes will lose interest and much of the psychological value of the moment will be lost. Never again will it be possible to awaken so easily a zest for accomplishment among the rank and file of employes.

**When to Start.**—Plans for undertaking the work may be prepared at any time and should be perfected well in advance of publicity, but there are times more favorable and times less favorable for actually getting the work under way. Most industrial plants must meet a fluctuating demand for their products, usually accompanied by changes both in the number of employes and in what might be termed "working pressure."

It is probably best to plan for the launching of the safety movement during a period of reasonably constant production and at a time of low rather than high working pressure. During the decline of the production curve, employes are uncertain of their jobs and the general morale may be low, while during the up-slope, labor shortage and other emergencies may bring about increased pressure for per-man production to the extent of actually interfering with safety activities. Employes are far more amenable to suggestion and discipline when jobs are scarce than during a labor shortage.

There are also seasonal considerations to be observed. During warm weather it is difficult to get payroll men to attend evening or other off-time meetings, while summer vacations may inter-

fere with the make-up of committees of salaried men. Early spring, late autumn or even winter should have the preference, although during the latter season open-air meetings are out of the question and, in a severe climate, little can be done toward improving the outside conditions of the plant. If the plant management has recently lost the confidence of its employes through wage-and-hour disputes or other controversies, it is then obviously a poor time to initiate a movement the ultimate success of which depends primarily upon general cooperation; it is best to wait until confidence in the management has been restored.

In the earlier days of the safety movement there were no recognized standards of safeguarding and, indeed, very little available information on safe practices of any sort, so that it became the custom for the employer, who was for the first time seriously undertaking accident prevention work, to call together his employes for the purpose of availing himself of their thought and experience before taking any action toward improving plant conditions. Times have changed, however, and today the industrial manager with the assistance of the National Safety Council, insurance inspectors, state and national safety standards may go a long way toward making his plant physically safe without aid and advice from his payroll employes.

The author believes that in most cases this work should be done (at least in so far as it pertains to necessary repairs, the safeguarding of ordinary machinery, platforms, stairways, etc., and the removal of well-recognized hazards), before the initiation of that part of the safety movement which involves the appointment of safety committees of payroll men. Failing to do it, a flood of obvious recommendations may be expected from these committees, which it will be physically impossible to accept and carry out with promptness sufficient to meet their expectations. Individual disappointment will be the inevitable consequence, the interest of the men will suffer and the employer's integrity of purpose may be seriously questioned. This, of course, should by all means be avoided since it may constitute a decided setback to the movement.

**Program.**—It is not possible to present here a program which will meet the requirements of any given plant, but we may at least set down a logical sequence of events that can be used as guide in developing a specific program:

1. Preliminary discussion of accident situation with members of staff.

2. Employment or designation of safety engineer or service supervisor.

3. Study of previous accident record by safety engineer and preparation of report.

4. Preliminary study of physical conditions of plant by safety engineer and preparation of report containing general recommendations for immediate improvements.

5. Consideration of reports by plant manager and staff and designation of assistant manager to head safety work as chairman of works safety committee.

6. Assistant manager and safety engineer prepare general plan of organization and initiate work on recommendations for general improvements. Plan discussed at staff meeting and followed through by department heads to their foremen so that work may be facilitated and made effective.

7. Safety bulletin boards erected.

8. Manager, assistant manager, and safety engineer confer on appointment of works safety committee. Appointment announced at staff meeting and on bulletin boards.

9. First meeting of works safety committee with manager present. General instructions to committee. Presentation of plan for organization of departmental safety committees. Date set for employes meeting posted on bulletin boards and individual foremen advised through department heads.

10. Selection of departmental safety committees through conference with individual department heads.

11. General meeting of all employes at which safety plan, appointment of committees, etc. is announced.

12. Follow-up notices on bulletin boards.

13. Meetings of department foremen at which is announced the appointment of departmental safety committees.

14. Follow-up notice on bulletin boards.

**Employes' Safety Meeting.**—Some general notes on this meeting may not be amiss. Attendance should be made obligatory, otherwise the more refractory and difficult element, which it is particularly necessary to impress, will be missing. The only possible way in which full attendance can be secured is by holding the meeting on the company's time; in other words, paying the men for their time. This involves a comparatively small investment and is worth while.

The program of the meeting should be as simple, businesslike and direct as possible. There should be no entertainment

features, motion pictures or other distractions from its main purpose. Speakers will do well to employ cautiously the emotional "heart appeal" and avoid altogether the "Hurrah, boys, let's get together" attitude, both of which are difficult to handle effectively and often fail in their purpose. The attitude of the chairman and speakers, however, should convey the downright sincerity and determination of the company to put a stop to accidents.

The meeting should start punctually, consume not more than one hour at the most and convey the impression of precision, determination and sincerity. The plant manager should preside and open the meeting by stating briefly that accidents not only cause human suffering for which money cannot compensate but are a source of loss to employer and employe alike; that he has become convinced that they have no place in modern industrial life; that since their elimination is a matter directly concerning every person in the organization and can only be effected through mutual understanding and cooperation, he has called the entire force together to hear *his* plans and help initiate a movement with which they must be in entire sympathy. (Note the emphasis placed on the authorship of the plans whereby the manager at once establishes his relationship to the undertaking.) He should then introduce the first speaker, the president of the company or other executive not directly connected with manufacture and in position to speak with authority on policies and financial expenditure.

The executive's speech, which should also be brief and to the point, should bring out unmistakably that the officers of the company are not only in sympathy with the work but will stand squarely behind the plant management in its execution, authorizing all reasonable expenditures entailed. He should state that the business of the plant is production and that quantity and quality production at lowest possible cost is a duty owed the stockholders, but that he, for one, is convinced that this cannot be secured under conditions conducive to accidents. He should state further that if at any point in the movement a decision must be reached as to priority, safety is to be given right-of-way over quantity, quality and cost.

The plant manager should next introduce the assistant manager, if he is to be the leader-executive, and the safety engineer, explaining the latter's position as technical advisor on accident

prevention. The safety engineer's remarks should be confined to a brief review of the plant's accident record, citation of a few significant examples of reductions accomplished by other and similar plants and a concise statement of what he thinks the plant in question can accomplish if every man does his part. It should be couched in simple language avoiding the use of technical terms such as "frequency rate," "severity rate," and "disability." No tables of statistics should be read off and but few, if any accidents, should be discussed in detail. It will be well, also, to avoid mention of responsibility for individual accidents, any suggestion that the majority of the cases could have been prevented had the men themselves done their part and even discussion of actual methods of prevention, these subjects being controversial at this stage of the work.

It now remains for the manager to amplify his first remarks and, using the preceding speeches as supporting arguments, emphasize the need, the possibilities and the assurance of support from the officers of the company. He then asserts that even with these and the services of a competent safety engineer no real and lasting impression can be made on the accident record unless the entire force, salaried and payroll alike, supports the movement and actually does its part as individuals. He then proceeds to explain the basic reason for this: that the ways in which accidents can happen are myriad and no system of rules, instructions or safety devices, however elaborate, could ever be developed which would positively anticipate accident occurrence; furthermore, that even the most perfectly developed safeguards are not proof against the thoughtless, careless or reckless man.

Continuing, the manager states that, notwithstanding such apparently insurmountable obstacles, a large number of industrial plants have unquestionably demonstrated their ability to eliminate industrial accidents of all sorts over long periods of time, and that for this the efforts of the payroll men seem to have been almost wholly responsible. If this could be done at other plants and in more hazardous lines of manufacture, says the manager, it could be done also at their own plant, although it would require "thinking safety, acting safety and insistence on safety in the actions of the men around you." Safety rules would have to be rigidly enforced, chance-taking and horseplay abolished and future accidents would have to be regarded, not with tolerance as mere misfortunes, but, since they are truly

avoidable, as discreditable and a blot upon the good record of the plant. This would be the only right attitude for every man, and if employes were found who, after a reasonable period of time, could not or would not adapt themselves to this new point of view and do their part to make safe the work of all, they should be asked to seek employment elsewhere.

The next point made by the manager should serve as introduction to his announcement of safety committee appointments. Referring to the willingness of the company to do everything reasonable to make its plant physically a safe place in which to work, he should point out the advantages that must accrue from having the most experienced men on the plant give the subject mature thought. He then announces the appointment of the works safety committee, naming its members and enumerating its duties, and follows with the statement that special safety committees will also be appointed in each department. He places strong emphasis, however, on the point that these committees shall in no way relieve the foremen and operators of their own safety duties and that no one must regard them either as detectives employed to report other men's delinquencies or experts to whom the whole work of safety is to be left. They are to be the representatives of the payroll men in a general movement which cannot help but benefit all and, as such, are to assist the department heads in making safe the working conditions within their own areas. While bespeaking for the committees the earnest support of every man present, he should leave the impression with his audience that the committees are adjuncts and do not subtract from the work for which they as individuals will be held strictly accountable.

**Department Foremen's Meetings.**—Following the employes' meeting a notice should be posted on all bulletin boards stating the appointment of the works safety committee, and notices signed by the heads of departments announcing a special meeting of their foremen. These meetings should be held at different times, but all within a week of the employes' meeting, and should be attended by every foreman of the department in question, by the safety engineer and by at least one member of the works safety committee, preferably its chairman. The presence of the plant manager, while not necessary, is desirable.

The department head should preside and, after brief remarks by the manager or the delegate from the works committee and,

perhaps, by the safety engineer, on matters pertaining particularly to that department, the chairman should announce the appointment of his departmental safety committee. Following this he should lay emphasis on the duties of the individual foreman and vigorously dispose of any idea that the safety committee will relieve him of his responsibility. Throughout his remarks he will stress the possible accomplishments of the department, endeavoring to work towards the creation of departmental spirit, but without detracting from the plant effort as a whole.

The meeting should next be thrown open to general discussion which, however, should not last longer than a half-hour. Every effort should be made to get the men to talk frankly and freely and their suggestions should all be recorded and referred later to the department committee for its consideration. In order that the foremen may feel at the outset that they have an integral and important function to perform, it is necessay that neither the department head nor the safety engineer should dominate the meeting with plans or criticisms; in fact all suggestions from the men should be received at face value even if they are clearly destined to be rejected or modified later. The meeting should be adjourned while discussion is still keen.

**Continuance of General Meetings.**—While the program just outlined is suggested for use in large plants and those of medium size, it may be modified to meet local conditions, retaining, however, the cardinal principles.

The continuance of general meetings for employes or for foremen is a question to be decided locally. In many plants foremen's meetings are held regularly. Occasional conferences of this sort devoted to discussing the progress of safety work ought to be decidedly beneficial; all movements with an emotional quality seem to be benefited by holding an occasional "revival." In the safety movement this place is filled by the "safety rally," of which more will be said in a subsequent chapter. In any event, once the movement is initiated it should not be allowed to slow down and at all times there should be furnished to the employes ample evidence of unmistakable activity in accident prevention.

## CHAPTER XIV

## STIMULATING RIVALRY

Even in old age men retain their interest in sports and contests, but in youth they demand to be something more than mere spectators—they desire active participation. For this to be possible the game must meet certain requirements: It must be one within their personal limitations; it must be one which they can play understandingly; it must retain their interest. It is quite apparent that the games which endure are those which present opportunity for exercise of personal strength, endurance, foresight or skill and in which there is, at the same time, an element of chance. Another element, however, is required; a similitude to the experiences of life itself.

The "game" of accident prevention meets all these requirements and, if safety is staged as a contest, men who would otherwise give it but passing notice will enter into it and soon become absorbed. But, like any other game, the objective must be clearly defined, the manner of playing and scoring must be readily understood and the score itself must be made known. Furthermore, it is a game in which men are not opposed to each other but are, as a team, pitted against obstacles and hazards. To win, the entire team (the plant personnel) must "get into the game" and "play the game." Otherwise the goal line of effective accident prevention will never be crossed.

**Competing against the Plant Record.**—Commencing with the first safety meeting for employes, at which the safety engineer reports the previous accident record of the plant, efforts should be made and thereafter sustained to interest every one in the number of days that the plant is able to operate without the occurrence of a tabulatable injury. While frequency and severity rates (always accompanied by a brief explanation of the terms) should be regularly computed and transmitted to heads of departments and safety committees, and perhaps posted on bulletin boards, for general publicity the chief emphasis should be laid on the number of days without a tabulatable injury or,

as it is usually termed, for the sake of simplicity and brevity, the "no-accident record." On this basis the plant competes against itself in an endeavor to better its previous record and, if the effort and score are effectively advertised, general interest is soon aroused.

As the interest in maintaining an unbroken no-accident record continues to increase, which it will do as the safety movement of the plant makes progress, the greater will be the opprobrium of the unfortunate individual and department that finally spoils the record. While an occasional instance may be encountered where this has resulted in attempted belittlement or concealment of an injury, these occur, as a rule, in plants where supervision is already lax in the matter of reporting minor injuries for first-aid treatment, a condition that is in itself intolerable.

Maintained interest, on the other hand, leads to effort, often on the part of the men themselves, to get the injured back to work on the following working day, which is a most desirable reaction and should be encouraged, provided such cases are under competent medical supervision and the return to work is made subject to the doctor's approval. What is of greater importance is that the same interest leads eventually to watchfulness on the part of the payroll men over the daily actions of their fellow employes.

An actual instance of this will serve to illustrate: Foreigners were employed in unloading coal cars on a high trestle. Several types of safety belts and life lines had been tried out but the combined efforts of foreman, safety committee and safety engineer were unavailing—the men would not wear any belts. When discipline was attempted they merely quit and those who took their place were equally obdurate. After discussion at the "works conference" the effort was finally abandoned as hopeless. A few days later the surprising discovery was made that all the men in the cars were wearing safety belts. An investigation disclosed the fact that some of their countrymen, hearing of the matter through the report of their representative at the "works conference," had taken affairs into their own hands. Exactly what they had said to the delinquents was not revealed—it must have been effectively expressed—but the substance of it was, "we are not going to have you fellows spoiling our safety record!" "Our record" was in this case the no-accident record of a plant employing 1,800 men and women of mixed nationalities!

It may be sufficient to post the no-accident record on safety bulletin boards but it is usually better to provide for this purpose a special large-size board at or near the gate where it cannot escape the attention of employes entering or leaving the plant. This board should show not only the current score in days but the plant's best previous record, the date of the last tabulatable injury (with a brief description of the accident) and the name of the department in which it occurred. Such a board may be simply and inexpensively constructed and some device to attract attention may be added in accordance with the tastes of the plant. Sometimes a flag is flown on every day in which no accident occurs, sometimes a crowing rooster or a broom is displayed and often thermometers, clocks or other scoring devices are employed. At all events, the board should deliver its full message simply and effectively so that everyone may know the score.

However effective the score board may be of itself, it probably cannot be relied upon as the sole vehicle for publicity. The plant's record must be advertised by every means available; it must be referred to in meetings, in talks with foremen or men and in the plant publication, if one exists; in a word, it must be kept continually displayed in one form or another where it will attract attention and become the subject of general discussion The works safety committee and safety engineer should be constantly alert to detect signs of flagging interest and devise new ways in which the subject may be kept alive.

**No-accident Campaigns.**—If a plant is so large or its injury frequency so high that there is scant probability of its establishing a no-accident record which would receive enthusiastic reception, it may be more expedient to select a definite goal, not too remote at first, toward which the plant may work. A little study of the injury records will soon reveal the relative frequency of injury occurrence and such a goal may be selected accordingly. Let us suppose, for example, that a plant has had 24 tabulatable injuries during the previous 12 months and the longest accident-free period has been 21 days; the goal might be set at 90 days which would probably be readily attainable and would be a long enough period, in view of the normal injury frequency, to minimize the effect of chance. Two or three attempts might be necessary, but realization of final success and of the aggregate result of the series of efforts would encourage the entire plant to go after a still better record.

The preceding statement can be made clearer by citing the case of a manufacturing plant in northern New Jersey employing about 1,800 men and women. The record of this plant in number of tabulatable injuries per month is shown in Fig. 5. There were 22 cases in 1922 and 20 in 1923. Toward the end of the latter year it was decided to work for a no-accident record of 150 working days, but without first arriving at a clear understanding as to the inclusion of Sundays during which about one-half the operating force worked on clean-up and repairs. The plant actually ran 144 working days, or 172 calendar days, before an injury occurred.

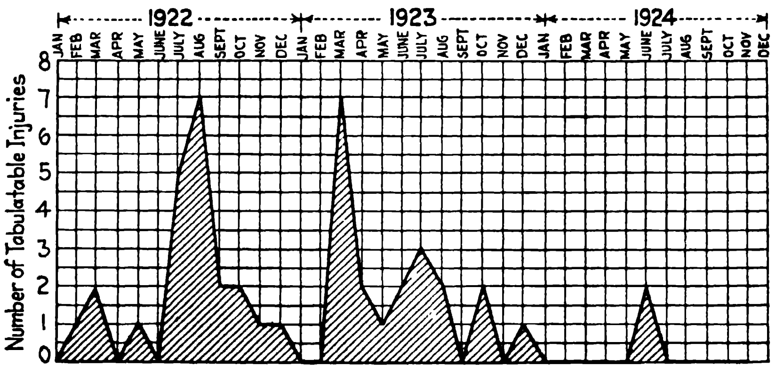


FIG. 5.—Injury reduction in a manufacturing plant employing 1,600 men and women. (*E. I. duPont de Nemours & Company.*)

Meanwhile there had been a slight controversy over the rules of the competition, resulting in some feeling on the part of the plant that its effort had not been appreciated. Another injury occurred and the plant, fired with a determination to show what it could do, voluntarily set about creating a new record. This time it accomplished 194 working days or 230 calendar days. Thus it was that during 1924 the plant had but 2 tabulatable injuries against 20 in the previous year and was in position to realize that a year without an injury was by no means an impossibility, a suggestion that would have received little credence when the no-accident contest was first undertaken.

The chart reproduced in Fig. 5 presents points of more than passing interest. Two periods of relatively high injury frequency may be noted: one commencing June, 1922, the other

commencing February, 1923, and both continuing for 6 months. Each period is distinguished by a large number of injuries in the first month and by a more or less regular decline thereafter. This may be interpreted as the result of conscientious effort following the awakening of a sense of responsibility incident to the occurrence of an alarming number of serious injuries. Evidently, however, in neither case did the effort reach far enough or was sufficiently sustained to make a lasting impression—as it did in 1924.

The following general comparison is of interest:

| | 1922 | 1923 | 1924[1] |
|---|---|---|---|
| Number of non-tabulatable injuries | 22 | 20 | 2 |
| Number of no-accident months | 3 | 4 | 11 |
| Calendar days in no-accident periods in excess of 50 days ....... .... | 51 | 51 | 172 |
| | 68 | 52 | 230 |
| | | 68 | |
| Total | 119 | 171 | 402 |

[1] Includes 1925 to Feb 7, when an injury occurred.

In selecting a no-accident period two pitfalls should be avoided: selection of a period so short that a "freak performance" is possible or a period so long that interest cannot be maintained.

Several years ago the Barksdale plant of the duPont Company with 200 employes established a notable record for a plant manufacturing high explosives and acids—over 2 years without a tabulatable injury. When this record came to the attention of the president of the company he offered prizes to plants or laboratories able to establish equivalent records. To the Safety Division of the duPont Company was assigned the task of determining what should constitute an equivalent record in plants manufacturing a wide variety of products and employing from a few men to over 2,000.

In attacking this problem, it was decided that the varying character of the work and its inherent hazards could be disregarded since they appeared to affect injury severity rather than frequency, it having already been demonstrated to the company's satisfaction that low frequency rates were possible


PLATE XI.—Safety Bulletin Board. (*E. I. duPont de Nemours and Company.*)

PLATE XIIa.—Hand Protection on Slip-stone for Sharpening Sheeter Knives. (*E. I. duPont de Nemours and Company*)

PLATE XIIb.—Face Shield for Chemists. (*E. I. duPont de Nemours and Company.*)

(*Facing p. 29*)

operations usually considered hazardous. Using as basis 200 employes for 2 years and the assumption that the no-accident period should vary inversely with the number of employes, a curve was drawn. This was not satisfactory, however, since it indicated only 1 month for a 2,000-man plant—rather too short a time for the establishment of a dependable record—and 6 years for the smallest plant—too long a period over which to hold interest.

On the assumption that interest could be maintained for 3 years on a small plant and that 3 months was the shortest admissible period for a plant employing 2,000 men, an empirical curve was constructed, keeping in mind the relative size and distribution of the plants and the possibility of creating rivalry among them. Upon this curve the table and rules given in the Appendix were formulated and have been used as basis for the contest since Apr. 1, 1923. During this period, 12 plants or laboratories, varying in size from small to the company's largest, have become eligible for prizes. While the method of computation is not exhibited as an example of scientific accuracy, the table has proved rather satisfactory under the conditions of its use.

**Competition between Departments.**—Another way to arrive at results is through competition among departments of the same plant. This may be an effort to secure the best interdepartmental no-accident record, in which case departments compete against each other, or a separate intradepartmental effort by each department to better its own previous record. Each form has its advantages, but the latter is probably to be preferred since it appears to detract less from interest in the plant's record and presents less opportunity for interdepartmental controversy over the method of scoring. On the other hand, the former type is to be preferred for a like contest between similar plants or between similar divisions of the same plant among which there is already keen rivalry and no great difference in operating conditions. Friendly rivalry should certainly be encouraged, but not to the point where it interferes with plant spirit. If rivalry becomes bitter it is high time to seek a different form of competition.

The basis of competition in any contest may be the frequency rate, the severity rate or the no-accident record. In small plants or small departments, however, injury rates, and espe-

cially the severity rate, being subject to erratic fluctuations, make a comparatively long contest period a practical necessity. A better response seems to be had when such competitions are based on no-accident records.

**Housekeeping Contests.**—Rating the various buildings or departments of a plant on the basis of their general housekeeping conditions as revealed by the periodic inspections of the works safety committee has been found to be effective in creating interdepartmental rivalry, promoting safe working conditions and raising the standard of plant housekeeping. A typical rating form will be found in the Appendix. Appropriate values for "credits obtainable" may be selected in accordance with matters that call for special emphasis in the plant in question. After the inspection, a copy of the rating sheet is forwarded by the committee to the head of the building or department with request for comments. The ratings of all buildings or departments are regularly posted on the bulletin boards, or the buildings themselves may be placarded with their ratings.

**Prizes and Rewards.**—Should prizes or rewards be given for the completion of no-accident records, and, if so, what form should they take? These are much mooted questions and any answer must be qualified by the statement that much depends on the quality and constancy of the personnel, its loyalty to the plant and its interest in safety.

In contests between plants some sort of trophy seems desirable, but as a *trophy* and not as a prize of intrinsic value. Within the plant the author favors some form of entertainment with or without individual souvenirs, believing that it can be utilized more effectively to accelerate the safety movement. To this a simple trophy may be added on which the name of the successful department is inscribed. Even an ordinary broom or a flag may be used. The individual souvenir may be a safety button, pin or watchfob or an inexpensive billfold, notebook or pocketknife. It is often desirable to leave the actual choice to a vote of the men themselves, since this usually increases the interest and provides further opportunity for making the most of the accomplishment.

The amount of money that the company is justified in spending on trophies or prizes can readily be computed from an estimate of the number of injuries prevented and the average cost per injury.

The argument that the entire credit is not due the men alone is offset by the fact that the true cost of injuries, including intangible items, may be double the book cost. Furthermore, part of what is expended can be considered as reinvested and likely to yield future dividends. The actual amount per man usually varies from $1 to $5, depending on the length of the no-accident period and the number of men involved.

If the award takes the form of entertainment no efforts should be spared to realize on its inspirational value for the future and, of course, both salaried and payroll men should attend. Some plants have adopted the plan of celebrating a 1-year departmental no-accident record with a dinner, clambake, picnic or excursion for members of the department alone, a 2-year record by including their families and a 3-year record by including the entire plant as guests of the successful department. This gives an opportunity to "rub in" the lesson on the less successful departments. Beside their use as rewards for service such entertainments help to promote closer acquaintanceship and loyalty.

Many helpful suggestions on special score boards and contests of various sorts are to be found in the publications of the National Safety Council. The reader is referred in particular to *Safe Practices Pamphlet* 51, "Planning an Industrial Safety Campaign."

## CHAPTER XV

## MAINTAINING INTEREST

While existing conditions may call for special drives against prevalent hazards and for meetings intended to serve as revivals, better progress is made by maintaining an even pressure than through a series of spurts. Yet it must be remembered that, however successfully the movement may have been initiated, it cannot carry itself by its own momentum. The executive or safety engineer who, having established his safety committees and bulletin boards, conceives that he may sit quietly by and watch them do their work, is doomed to disappointment. The mere launching of the movement is not half the battle.

We may say to those responsible for the safety work: If the accident record shows an early reduction by all means feel encouraged, but remember that a large part of the reduction has probably been affected through appeal to the emotions, the freshness of which may soon wear off, and that the men are at any moment likely to slip back into the carelessness that has been the accustomed habit of years.

New habits of thought and action must be not only formed but firmly established. Safety must become the atmosphere of the plant, so potent as to make its influence felt by all. To accomplish this may well be the work of years, not months, and during the formative stage each relapse simply postpones the ultimate arrival of final success. Throughout the effort the movement must be kept vitalized; interest must be maintained and fed constantly with new and constructive ideas.

**Committee Meetings.**—Nothing should be allowed to interfere with the regularity of safety committee meetings. Full and punctual attendance should be required and the minutes should be circulated among all those who could possibly benefit thereby. It is often desirable that the more important recommendations, at least such as apply to conditions affecting any large number of employes, be posted on the bulletin boards. The names of committee members should also be kept posted.

Not only is it necessary to give as much publicity as possible to the work of the safety committees, but their members must be supplied with information that will be both helpful and inspirational.

The works committee, in particular, should have ready access to all safety standards and to the reports and regulations of the state department of labor, as well as to such publications dealing with accident prevention as *Safety Engineering*, *The Traveler's Standard* and, in particular, the *National Safety News*, and *Proceedings of the National Safety Council.* Not only should current numbers of safety periodicals be passed around but members should be encouraged to take them home and peruse them at their leisure.

A better plan is for the company to take out a subscription for each member of the works committee and have the magazines mailed directly to his home address. In this way the members not only gather information and inspiration while uninterrupted by other business duties, but their families eventually absorb some of it, ask questions and contribute indirectly to the general interest. The expense is relatively trifling.

One of the functions of safety committees is to act as clearing house for safety suggestions. Here it may not be amiss to point out that the safety engineer who is inclined to gather all such matters into his own hands should realize that the strength of the local safety movement, and with it his own value and importance, will increase with the mental growth and broadening of the safety committees. For this reason he should do everything in his power to serve and stimulate them. This, of course, should often lead him to refer to them matters which he himself would be perfectly capable of handling, and to bring to their attention the best of the accident prevention information which reaches him from outside sources.

By helping others do effective safety work no safety engineer works himself out of a job; on the contrary, he makes for himself a far better and more secure position and, at the same time, clears his own way toward the more interesting and remunerative phases of accident prevention work. "No man," says H. W. Forster, "can grow in unselfish labor without benefit to himself but in a real safety man service is the goal, not personal advantage."[1]

[1] "The Safety Engineer—His Privileges and Opportunities," *Proc. Nat. Safety Council,* Thirteenth Annual Safety Congress, p. 129, 1924.

**Accident Publicity.**—In preceding chapters it was stated that accidents should be investigated by both departmental and works committees; that therein their members would constantly derive inspiration for constructive work. The principle is applicable as well to employes not serving on committees who have become interested in accident prevention. To this end a carefully prepared description of every serious accident and of near-serious accidents which teach a lesson, illustrated if practicable by sketches or photographs, should be posted on the safety bulletin boards.

If an unsafe appliance or a safety device has figured in an accident case it may profitably be exhibited. Broken ladders, mushroomed chisels, tools with split handles, boards with projecting nails, defective wrenches, broken scaffold planks, all make effective displays especially if they have caused an accident, while equal interest will be aroused by goggles or other appliances that have prevented accidents if accompanied by a brief description of the case, preferably including the name and position of the man concerned. After such articles have been once displayed they should be saved to make part of a collection —such as a pile of broken ladders, defective tools or upturned nails—that may be exhibited at the end of the year. Even the results of a good housekeeping drive may be profitably advertised by exhibiting the material collected before it is sorted and finally disposed of.

The author has observed that in some plants there is reluctance on the part of the management to permit the public posting of information on accidents. The reasons given for this are usually the following:

1. Tends to magnify in the minds of employes the hazards of the employment.

2. Is a form of negative rather than positive teaching and suggests bad practices that might not otherwise be thought of.

3. May have an adverse effect on damage suits or referees' decisions or be used by unscrupulous lawyers to influence employes to take legal action.

To all such objections there is a general answer: Far more harm is done by rumors, exaggeration and half-truths than by the facts of any case. When an accident occurs, the employes hear of it and it is infinitely better to confront them with the truth than leave their minds to the mercy of wild tales that expand

as they are passed from mouth to mouth. More specific answers may also be found.

Does the occurrence of accidents cause employes to magnify the hazards of their employment? Industrial experience, on the whole, denies it; in fact, employes belittle the probability of accident occurrence. This is one reason why a safety movement has become necessary. For years the author has followed closely the results of accident prevention in what are usually termed "extra-hazardous" industries and he has yet to observe an occupation so hazardous or so marked by catastrophes that it was difficult to secure applicants for the jobs at ordinary wages. Men, as a rule, fear not what they know, or think they know, but what is unknown. No matter what the hazards of the occupation may be, one always encounters difficulty in arousing in labor a respectful appreciation of the dangers of its employment. This is just as true of the common occupations as it is of the manufacture or handling of explosives, strong acids, poisons or other materials possessing marked inherent hazards.

There are many arguments in favor of the positive as against the negative form of teaching, but the latter must always supply the reason for the former. We cannot, for example, teach convincingly the danger of a stream of compressed air directed into the body by employing the positive form, and we must even supplement a statement made in the negative form by saying just what has happened in cases too frequent to enumerate. The fact is that in the cases which have occurred, although manslaughter was presumably never contemplated, death has almost always resulted, and that has made it incumbent upon the employer to publish the facts and warn his employes of the danger.

Under the common law it became the duty of the employer to provide a reasonably safe place in which to work, reasonably safe tools, reasonably safe and competent fellow employes and reasonable instruction in the way the work should be performed. The latter obligation carried with it the provision of reasonable information on the hazards of the work. But beyond this and of transcendent importance is the moral obligation of the employer to acquaint his employes with the known hazards of their employment. There surely is no more certain and effective way of doing this than by publishing information on the accidents that have occurred among them or among employes in similar

industries. This duty is paramount to the employer's protection of himself against possible legal action or claims for compensation, whether justly or unjustly made.

In the author's opinion the employer who is honestly undertaking to make his plant as safe as is reasonably practicable has nothing to fear from the criticism of his employes, provided he does not undertake to lay the blame unjustly, avoid payment of what is due, or disguise the truth of actual conditions. Indeed, where the safety movement has been well established, the employe who has been injured through some obvious fault of his own will be more censured by the men than the employer who has failed to eliminate an obscure hazard.

The only other valid objection to complete publication of the details of an accident may be that entertained by the injured man himself who fears being held up to possible ridicule. This is more imaginary than real and the victim may usually be talked into permitting his name to be used if it is shown that by so doing it may prevent injury to others. Its use, however, is not essential, for if the date, place of employment and occupation are given, the man will be promptly identified.

**Safety Bulletin Boards.**—There is no doubt of the value of safety bulletin boards as a medium for disseminating general and special information on accident prevention, for maintaining interest and for strengthening the conviction among the employes at large that accident prevention is not merely the hobby of the plant manager but is an integral part of a great industrial movement.

Such boards may be purchased ready made or can be constructed at small cost. Proper type, number and size, whether they should be placed indoors or outdoors, where they should be located and whether they should be illuminated at night can only be decided on the basis of local conditions. Each case merits careful study and in all cases decision will rest upon the application of mere common sense. The boards must be so placed and maintained that they may be examined by the men without personal inconvenience during moments when they are not otherwise employed.

That they will be studied by the men is quite another matter and depends on a number of factors, all of them within the management's control. First, the material posted must be fresh, interesting, appropriate and true; one unsound or amateur-

ish poster that provokes ridicule may "queer" a board for weeks to come. Second, the board itself must be neat, well painted and suitable for the purpose. A shabby, dirty, unkempt or poorly lighted board repels attention and labels the safety movement "unimportant." Third and most important of all, the employes must be already interested in accident prevention.

Safety bulletin boards do not alone prevent accidents and the mere posting of safety bulletins, no matter how strong and compelling their message, will not of itself engender a spirit of safety on the plant. If the employes do not appear to be much concerned with what is posted, it is due more often to the management's failure to have aroused properly their interest in accident prevention than to any flaw in the logic of this sort of publicity. On the other hand, one often encounters poorly maintained or otherwise uninteresting boards and it may be well to call attention to some of the more frequent and conspicuous defects:

1. Inappropriate material posted, usually because the manager posts everything received from his insurance company or other source of poster service. In other words, the boards are maintained perfunctorily.

2. Too much material posted at one time and new material too seldom posted. This is usually to save time and labor. Something new should appear on every board at least twice a week, and an equivalent amount of old material should be removed. No poster should be allowed to remain until it fades and looks old. The boards should not be crowded with posters; there should be a clear space of at least 2 inches framing each poster.

3. Too much "canned" material and too little material containing local color. This results from following the path of least resistance, *i.e.* using purchased poster service exclusively. A little initiative will develop local sources of excellent material such as descriptions of accidents, near-accidents and safety devices, pen-and-ink sketches, photographs, blueprints, typed matter, newspaper clippings and illustrations which will not only lend variety to the general aspect of the board but will carry their message.

There are a number of sources from which appropriate safety posters can be obtained. They are furnished by some of the liability insurance companies and trade associations, by some manufacturers of safety devices and by a few commercial firms,

but the most varied and effective assortment is issued by the National Safety Council as part of its service to members. While the latter organization regularly produces a number of new posters each month, a catalogue is maintained from which its members may select and purchase at low cost posters that are especially adapted to specific industries. Hundreds of different sorts are available: positive, negative, humorous, serious, gruesome and wholesome.

Because one frequently hears the relative merits of different types of posters discussed, it may be apposite to point out that the tastes of those to whom the safety appeal of posters is directed are no less varied than the posters themselves. This is argument, therefore, against the selection of any given type and in favor of a constantly changing array, supplemented by judiciously selected material of local origin. If this is done, the author believes that there will be no real reason to display on the same board, as "bait," current event posters, baseball scores and other material not directly related to safety.

If the boards are properly located and maintained and if the spirit of safety is really alive on the plant, what is posted will be read and discussed.

**Suggestions and Questionnaires.**—It is customary to urge the men to hand in suggestions on accident prevention and many plants maintain "safety suggestion boxes." These were probably very useful in the earlier days of the safety movement and still may be useful in any plant during the early stages of its safety effort. But after the movement has been well established, most suggestions will be made naturally to the foremen, to members of the safety committees or to the safety engineer, who if they are properly trained and have the success of the movement at heart, will see that they are received in the spirit in which they are given, that they are accorded careful consideration and that their authors are not only advised of their acceptance or rejection but are frankly told the reasons.

As in the case of no-accident competitions, the question of rewards confronts the safety engineer. Personally the author does not believe in the principle of rewards for what the unselfish man would contribute to alleviate suffering without thought of recompense, and believes that rewards offered for safety suggestions produce very few ideas that are both novel and valuable. Probably the reasonable way of disposing of this difficult question

is by stating that if the plant has a "suggestion plan" or other orderly method of handling suggestions from its employes, safety suggestions should be accorded the same treatment as suggestions on other subjects. If there is no such plan or method, it is not improbable that the same or better results can be obtainable through certificates or letters of commendation, copies of which are posted on the bulletin boards.

Aside from any intrinsic value of safety suggestions,[1] there is profit to be derived from any undertaking which stimulates thought on accident prevention by the less thoughtful among the rank and file of employes. For this purpose questionnaires are useful, though they should not be sent out at regular intervals or oftener than once in 2 or 3 months. It is advisable that they be sent to every foreman or even to every payroll employe, if feasible. Therefore they should be brief and pointed, with questions selected to induce thought rather than educe ideas. To obviate collusion it is desirable that they be sent to employes' homes, in which case a stamped and addressed envelope may be enclosed or arrangements made to receive the questionnaires at the gate. A full return should be insisted on and foremen should be requested to follow this up. Some examples of typical questionnaires that have been used successfully will be found in the Appendix.

**Safety Rallies.**—While the ultimate success of the safety movement rests upon appeal to reason rather than to the emotions, many, even among executives, will be found to respond more readily to the latter. Emotional ardor, however, is apt to cool quickly and therefore requires frequent revival. This is accomplished more thoroughly and with less effort through the medium of mass reaction than through individual contact—hence the *safety rally* (already mentioned in a previous chapter), involving more or less emotional appeal, in contrast with the *safety meeting*, in which the men are drawn together for the purpose of instruction, discussion or the transaction of specific business. As a matter of fact, these terms are used rather indiscriminately and in many safety gatherings both types are combined as, for example, in the meeting at which the safety movement is initiated.

[1] The author personally reviewed a great number of safety suggestions received under a "suggestion plan," but while a number of awards were made, the net value of the suggestions was, in the aggregate, exceedingly small.

Inspirational meetings are often held in shops or in the open air, but in this case must be brief, especially if held at noon or on the company's time. It seems somewhat better practice, however, to hold the safety rallies outside the factory premises in a suitable auditorium or motion-picture theater removed from the workaday atmosphere. The secret of securing attendance is a liberal amount of advance publicity, ready accessibility, punctual starting and a program that provides some entertainment, goes smoothly and is not unduly long. As a rule, wives and children should be invited, not only because they help to bring the men but because they subsequently exert an influence for safer conditions. Admission tickets are desirable as they add dignity and help advertise the meeting.

An officer of the company, in preference to the safety engineer, should preside. Some music is almost essential, even if merely a piano played while the audience is arriving and during the pictures. To lighten the program other entertainment features are highly desirable. They may be of almost any sort provided they are really entertaining and do not detract from the real purpose of the meeting. Good local amateur talent is usually plentiful and is generally appreciated, but poor amateur talent is expensive in that it hurts the attendance at future meetings. It should never be engaged on the recommendation of friends and put on without trial, as the results are apt to be disappointing.

The frequency with which safety rallies should be held is not a matter which can be prescribed for a given plant or even forecasted in advance. It will always depend on prevailing conditions. The best that can be said is that such meetings should be held when there are unmistakable indications of flagging interest. This will probably occur oftener in the early stages of safety work than later. The author's experience has been that an inspirational meeting of some sort is needed at least once a year.

**The Emotional Appeal.**—There are many ways in which an emotional appeal may be made successfully to a mixed body of working men, but there is none better than having an experienced speaker who knows his subject and knows how to "get it across" to his audience. On the other hand, a strictly emotional safety speech by a man unfamiliar with his subject, unaccustomed to facing an audience, unused to contact with working men, or one who talks over their heads or "down" to them or

directly athwart their point of view or is not himself sympathetic to the safety movement, is no more than wasted time.

Emotions may be stirred by speakers who are not themselves emotional provided the substance of the address has strong emotional appeal. There is nothing better for this purpose than stories of actual accidents—not the brief, cold enumeration of conditions leading up to an accident, of the physical injury and of the degree of probable disability (as might be read from an injury report), but the story of the circumstances and results and after-effects, not dramatically related but laid before the audience as bare, unvarnished statements depicting human tragedy. Material for such stories can be found in every industrial plant, provided one undertakes to uncover the inside facts and develop the human side of injuries as they occur. They may be also gleaned from the newspapers, sometimes told dramatically, as in the story of the Tanners, and sometimes recited more simply but with telling effect, as in the story of Mary Wisniewski, both of which are included in the Appendix.

A speaker from the outside is an attraction. Regardless of his ability to deliver an address that is emotionally effective, he helps to broaden the viewpoint of his audience if he pictures the breadth of the industrial safety movement and talks intimately of safety work on other plants. The average employe, although he hears a great deal about "Safety First," seldom seems to realize that it is a live issue on plants other than his own, and any opportunity to undeceive him should be accepted. Speakers from the outside are often able to do this where the officials of his own company would fail. Such speakers are not difficult to obtain from other industrial organizations, insurance companies, departments of labor and the National Safety Council and they are usually glad to address meetings of this sort without asking any recompense other than their traveling expenses. Good emotional speakers on safety, however, are more difficult to obtain, and some of the best, because of the insistent demand for their services, are forced to ask moderate fees.

**Safety Motion Pictures.**—Motion pictures with a safety lesson are an effective medium for both inspiration and instruction. Those produced in the last few years are infinitely superior to the earlier attempts, many of which failed to carry conviction, but the selection, though varied, is unfortunately, not large. It is possible to obtain films dealing with the specific hazards of a

few industries only and other industries must for some time be satisfied with pictures that dwell on the common industrial hazards. The other type of picture tells a story with a safety lesson and is more suitable for exhibition when the families of employes are present.

Films can usually be obtained at a very moderate rental from the producers or copies can be purchased outright for use on a large number of associated plants. The National Safety Council, beside producing occasional pictures, is able to supply information on what is generally available.

**Safety Drives and Safety Days.**—While, as already pointed out, the safety movement should not be carried on as a series of drives, an occasional drive will help to stimulate interest. The usual form is a no-accident drive or a no-accident competition, both of which have been sufficiently described in the preceding chapter. Another effective form is the special "day," on which a drive is made against some specific and prevalent hazard. A favorite is Ladder Day, when all defective ladders are routed out, collected and burned, except, perhaps the worst ladders which are preserved for exhibition as "horrible examples." Defective Tool Day, Projecting Nail Day, Good Housekeeping Day, Unsafe Scaffold Day and others may be staged. There should also be local observance of such quasi-national events as Fire Prevention Week, Red Cross Week and Clean-up, Paint-up Week, accompanied by appropriate plant activities.

When properly advertised and followed up, possibly with encouragement in the way of small prizes, or even booby prizes, safety days will arouse interest and improve plant conditions. They are of greatest value, of course, in the early stages of safety work, for it must be said that on plants under vigilant inspection, where safe working conditions are maintained, there should be no need of drives on the common, well-recognized hazards.

Many suggestions on special "drives" and "days," as well as many other schemes for maintaining interest, are to be found in *Safe Practices Pamphlet* 51 of the National Safety Council.

**Bonus Systems.**—In this and the preceding chapter the author has expressed his general disapproval of the principle of cash awards for safety service. It would be unfair, however, to dismiss the subject leaving the reader to the conclusion that the safety bonus is necessarily wrong in principle or an improper or ineffective incentive for heightening interest in accident preven-

tion. Many employers have made effective use of the bonus and have been rewarded with material accident reductions. A large number of electric railway companies have adopted safety bonus plans. Their accumulated experience with them, or such of it as could be ascertained, indicated an average reduction of 50% in claims expense as per cent of gross receipts. One large city railway showed the following reductions during 24 months as compared with the preceding 24 months:

| | Per Cent |
|---|---|
| Accidents | 24 6 |
| Claims | 24 5 |
| Collision of cars | 66 7 |
| No report cases | 47 8 |
| Serious injuries | 42 0 |
| Injuries not serious | 24 6 |
| Deaths | 43.7 |

In reporting on this survey, G. T. Hellmuth, Claims Attorney of the North Shore and Milwaukee Railroad Company meets the objection to the principle of safety bonus with the following statement:

It is said by some objectors that it is not right in principle to reward men for doing unusually well what they have been already paid to do. To me it seems that one may as well argue that one ought to work always in whatever endeavor one is engaged without any expectation of promotion or increase in pay. Personally, such a situation would deaden for me both initiative and mental activity. In fact, I do not think it would be too broad a statement to say that to work with the definite knowledge that no sort of reward could be expected, either in promotion or in pay increase, would inevitably take from any individual the incentive for extra effort. And it is the extra effort, and the extra effort only, that will produce results above the average.[1]

Probably we may safely conclude that there are situations in which, and men with whom, a safety bonus will accomplish results which other incentives will fail to produce in so short a time. This might be particularly true where employes were removed from immediate and constant supervision, as, for example, when operating trolleys, trains or automobiles.

[1] "What Are the Results of the Bonus and Award System?" *Proc. Nat. Safety Council,* Fourteenth Annual Safety Congress, I, p. 376, 1925.

## CHAPTER XVI

## SAFETY RULES, INSTRUCTION AND THE NEW MAN

In every industrial undertaking the conduct of employes who have become habituated to their surroundings is governed by what is essentially accepted practice and by special rules or regulations promulgated by the employer. The former corresponds somewhat to the common law of our courts, and the latter to the statutory law. In a field of endeavor as new as accident prevention little dependence can be placed on the control of the individual through his acceptance of what is deemed common practice, for no real body of common practice has yet been established. For the present, we must rely almost entirely upon control by rule, supervision and direct instruction.

Safety rules, therefore, are of real importance and, in the absence of established safety practice and common usage, their preparation is deserving of more careful consideration and treatment than rules dealing with other matters. For the same reason, and also because so sacred a possession as human life is involved, their observance must be insisted upon. Without reasonable enforcement they are not only useless but weaken all other efforts to maintain safety. To the new man, always unfamiliar with his surroundings and unacquainted with the hazards of his new occupation, rules are meaningless and unimpressive until he realizes that they will be enforced.

**Form of Safety Rules.**—In most plants one finds "General Rules and Regulations" which are intended to govern the conduct of all employes. They generally cover a wide range of subjects and usually include some safety rules relating to common, well-recognized hazards, such as failure to report minor injuries, oiling moving machinery and exposing the eyes to flying particles. When combined in this form with other regulations they do not, as a rule, cover comprehensively all the common hazards that the employe will encounter. Where the processes of production have been systematized and the work is carried on in a more or less predetermined way, one finds special department or process

rules which include rules relating to department or process safety. In some of the larger and further advanced plants are found safety rule books or safety rules posted on placards.

Such segregation of rules pertaining exclusively to safety represents the best practice. Indeed, if the plant is large and subdivided into a number of separate departments each with its special hazards, the requisite safety rules are alone sufficient to fill a fair-size rule book. In such a case, there would be too many to placard, as well as too many for the employe to learn from placards. The safety rule book is the natural solution and the employe may carry it home for study or keep it in his pocket for reference. It is to be recommended for all large and many smaller plants.

Safety rules should be direct, clear and as brief as possible, but it is most important that they be at the same time comprehensive and specific. Responsibility should be clearly defined. A rule which reads "Guards must be replaced before machines are operated," is poorly worded since it leaves the responsibility undefined. Two rules are really needed here: "After machine repairs mechanics must immediately replace guards" and "operators are forbidden to operate machines when guards are not in place." In a well-arranged rule book the former rule would be listed under "Rules for Mechanics and Repairmen" and the latter under "Rules for Machine Operators."

A common error is the promulgation of general rules which are loosely worded and to which there are permitted exceptions that are not mentioned in the rule. Such a rule as "You are forbidden to oil moving machinery" in plants where oilers and power house attendants do so as a part of their regular duties is apt to be broken by some individual who draws no fine distinction between his own "rights" and the duties of others. Moreover, knowledge of the permitted exception weakens the rule in the eyes of all. A better wording would be, "Only regular oilers, engineers and repairmen are permitted to oil moving machinery." This rule, however, is negative and unenlightening; the positive form, addressed to operators, would be an improvement: "Shut down your machine before oiling. Only regular oilers, engineers and repairmen are allowed to oil machinery in motion."

A somewhat similar criticism can be made of the usual rule, "Report all injuries, no matter how trivial." The author greatly prefers "Report at once to your foreman (or to the hospital)

every injury which draws blood or where a foreign body enters the eye or penetrates the skin." The former wording, although it has been generally adopted, is far too vague, and leaves too much to the intelligence of the employe.

Another example of a vague rule is "Wear goggles where there is danger to the eyes." It is infinitely better to specify in what operations goggles are to be worn and include this in the rules specifically governing such operations.

Of less value are such rules as: "Do nothing to endanger your fellow-employes"; "Avoid unnecessary risks"; "Do not use dangerous tools"; and "Be careful about your work." The precepts are good but the rules, if they can be termed rules, leave too much to the imagination.

Each rule should, without sacrifice of clearness and intent, be condensed into as few words as possible, but any attempt to limit the safety rules to a prescribed number or to a definite space should be discouraged. The criterion is that of clearness, relevance, usefulness and practicability. The fact that safety rules are intended for self-instruction and as guide for instructors, and only secondarily as a basis for discipline, should never be lost sight of. These objectives cannot be attained if the formulation of the rules is circumscribed by arbitrary requirements.

**Selection of Safety Rules.**—If a plant which has already organized for safety finds that such safety rules as it has are inadequate, it will be well to draw the foremen into the preparation of new rules in order to take advantage of their experience and enlist their support before the fact. They may be asked to suggest safety rules to the departmental safety committees, either as individuals or collectively at a meeting called for the purpose. The committees, on their part, after shaping up these suggestions, should discuss with the foremen their contemplated alterations of the original proposals before they are submitted to the department heads. If this is done, the foremen retain direct personal interest in the rules and will develop greater zeal for their enforcement than would be the case if the rules had originated higher up and had been forced on them. The final drafts should be submitted to the works safety committee, which should pay particular attention to correlation and codification of department rules and the segregation of general rules applicable to all departments.

Rules that are vague, non-enforceable or of doubtful utility should, of course, be rejected. If the suggestions made by the foremen are inadequate, which ought not to be the case if the meetings are properly conducted and the men are sufficiently encouraged and given time for thought, a review of state and national safety standards, insurance schedule rating manuals and the *Safe Practice Pamphlets* of the National Safety Council will furnish many ideas. The injury experience of the plant in question and of plants engaged in similar lines of industry should be reviewed for the purpose of selecting rules which, if they had been previously adopted and enforced, would have prevented actual accidents. It would be desirable, also, for the works committe to look over the safety rule books of some of the larger industrial corporations from whom copies may be obtained on request. They will prove valuable in furnishing suggestions on both substance and form.

**Enforcement and Discipline.**—Rigid, impartial, but not harsh enforcement of safety rules is an absolute essential. Judgment should not be hasty, action being delayed until all the facts are produced. Neither the length of service, the value, nor the position of the offender should be permitted to interfere with decisive action, taken, in military parlance, "for the good of the service." The factors of service, value and position should be given consideration in determining the nature of the penalty but should not affect the question of enforcement itself. To do otherwise will weaken the entire safety effort.

Needless to say, the enforcement of safety rules should be made uniform throughout the plant. A satisfactory method of accomplishing this through the medium of review by the works safety committee is explained in Chap. XII.

**Penalties.**—A schedule of appropriate penalties for common infractions should be selected in advance, although, in order to avoid embarrassment in difficult cases, it may be inadvisable to make it public. While, theoretically, the penalty for the infraction of a given rule should always be the same, such is not practicable and each case must be judged on its own merits. Many things must be taken into consideration such as the nature of the infraction, the circumstances leading up to it, the intelligence of the man and his understanding of the rule, his age, experience, value and position.

There are two questions of paramount importance for which an answer must be sought: What will be the effect of a given penalty on the man himself; and, What will be its effect on the body of employes and the plant safety movement? The main purpose in having safety rules is to maintain industrial establishment in which it is safe for all men to work and, as in the civil state, the privileges and rights of the individual must yield priority to the greater question of common weal.

It is difficult to set down definite rules for the application of discipline or even suggestions that will guide the reader in the many difficult questions that will confront him. In the following statements the author is expressing personal opinions based on observation rather than direct experience.

If the infliction of a penalty will make the plant safer for all, it should be inflicted; if only the man himself will be affected, as is rarely the case, and the infliction of the penalty should make him a safer man, it ought to be inflicted; if it is felt that the penalty would have the opposite to the desired effect, the question of discipline should not be dropped but other forms of penalty should be considered. If the man has been injured as result of his infraction, the question of penalty should not be finally dismissed on the assumption that he has suffered enough and learned his lesson, but on return to work he should be interviewed and an attempt made to ascertain his point of view especially in regard to the rule that was broken.

Some men do not automatically learn their lessons in this way and are repeatedly injured in accidents for which they are themselves principally responsible. If they cannot be corrected, these supposed "victims of circumstance" should be dismissed as soon as possible, since they constitute a hazard to other men. If not of this type, the injured man on his return to work, provided he has been fairly treated in the matter of medical attention and compensation, is in a state of mind peculiarly susceptible to safety teaching. This is a fine opportunity to make him "a safety man."

The penalty of dismissal is the severest for some men but seemingly of little consequence to others. Except in the most flagrant offenses, it is probably better to apply a lighter penalty, attempt a reform and dismiss only when the man proves incorrigible or otherwise hopeless. Through dismissal the employer faces the possibility of replacement by a new man who is a still

greater hazard. Yet there are many times when dismissal is justified. It has the advantage of being the most conspicuous form of penalty and therefore the most potent in its effect upon others. The more important and prominent the individual involved the more pronounced will be the influence of his dismissal and there is no more effective way of breaking up wholesale disregard for a general safety rule, for example, that requiring the wearing of goggles, then by dismissing a foreman for failure to enforce it. Suspension, as a penalty, is less efficacious and is apt to increase the hardship on the employe's dependents, thus engendering resentment.

The commonest penalty is temporary demotion to a less important or desirable job, to other duties at a lower rate of pay or by removal of the "service bonus," if such exists. It is effective and, if justified and explained, does not seem to be violently resented, especially if the offense was one that would have led in some plants to summary dismissal. On the other hand, a decrease in rate of pay *for the same work or job* will almost always cause an unfavorable reaction.

To the conscientious employe who values his job, a formal reprimand delivered verbally by the head of the department, superintendent or manager is a severe and effective penalty. Except for serious infractions or where a general effect is desired, such a penalty is probably sufficient for the first offense, but the reprimand should be delivered under impressive circumstances and only after the offender has been asked to give an explanation for his act. The reprimand should never be given publicly or even before a committee; ridicule is not only feared but is apt to awaken resentment.

**Publicity on Discipline.**—If penalties are applied for their moral effect on the mass it is obvious that in some way information on what has been done must be broadcast. This step is so obvious that it is surprising to find it often neglected. The usual excuses are that the transgressor has been punished enough, that he ought not to be held up to ridicule, and that others "will hear about it anyway." Doubtless, others do hear about it, but they seldom hear the entire truth and often only a distorted version.

Since the welfare of the majority is paramount to the sensibilities of the individual, the author recommends that, as a rule, all cases where penalties more severe than a mere reprimand are

applied should be posted on plant bulletin boards in the form of a brief description of the circumstances, reference to the broken rule and statement of the penalty. The individual's department and occupation should be mentioned but not his name. It is also well to state that the penalty was reviewed and approved by the works safety committee. The statement should make it clear that discipline was applied in order that the work of all might be made safer.

**Hazard of the New Man.**—Authorities agree that the new employe is more subject to accidental injury than employes

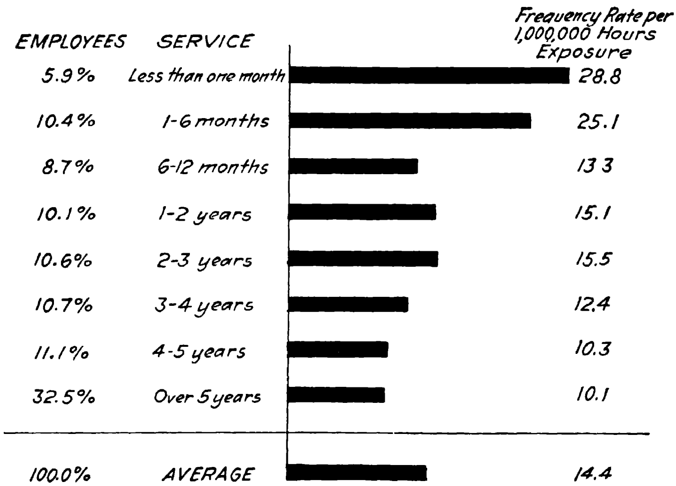


FIG. 6.—Injury frequency in relation to length of service. (*E. I. duPont De Nemours & Co.*)

who have had time to become familiar with their jobs and surroundings. Some authorities have found that injury frequency among new employes is three or four times as high as injury frequency among other groups. The duPont experience given diagrammatically in Fig. 6 shows the hazard of the new man to be twice that of all other employes. The divergence of these figures from the experience of others is probably traceable to differences in working conditions, character of labor, amount of instruction and other elements affecting the situation as well as to differences in methods of calculation.

It is conceivable that, other conditions being equal, the relative frequency of injury among new men in similar plants may

be a more or less reliable index of the vitality of the local safety movement. The stronger the general interest in accident prevention, the more intense the intolerance of carelessness and disobedience of safety rules, the more rapidly will the new men become imbued with the plant spirit. The fact that remarkable no-accident records have been made in the face of high labor turnover seems to bear this out. During the recent war when labor turnover was exceptionally high, skilled labor was scarce and rapid production or erection was stressed, some plants were able to maintain remarkably low frequency and severity rates.

The author has carefully studied the history of a number of creditable no-accident records in the hope of finding some similarity in the type of accidents which terminated the records. None was found, but it was noteworthy that among the men injured only a few were either new employes or old employes on new jobs. This does not indicate that the new man is not more liable to injury than his fellows, but suggests that his recognized liability to injury can be overcome by precept and example.

**Effect on Labor Turnover.**—The cost of hiring, instruction, breakage and damage, and decreased production due to the advent of a new employe seems tc vary from a minimum of about $10 per man for those rehired or for unskilled labor newly hired, to a maximum of $300 per man for positions requiring skilled operators. Turnover in the latter class is not usually high and about 75% of the total turnover is encountered among employes who have had less than a year's service, and are occupying positions that are often vacated and refilled every few months or oftener. These are obviously the less important positions and the cheapest to refill.

The amount of labor turnover in this country has been mentioned in Chap. VIII. Its cost has been estimated to exceed one and a half billion dollars per year. If turnover involved masses of the skilled rather than the unskilled workers, the cost would be at least doubled and the situation would be a serious one indeed. Any element, therefore, which tends to increase the rate of labor turnover among the skilled class is to be regarded with real apprehension. Accidents have this very effect, wherefore it becomes especially important to instruct properly the new man intended for a position requiring a skilled man and so decrease the liability of incurring not only the cost of an accident but the high cost of skilled man replacement.

**First Instructions.**—The new employe, as he applies for work, enters the plant and takes up his duties for the first time, is, in most instances, peculiarly susceptible to first impressions. Even outside the employment office he should be confronted with a sign that tells him that careless employes and those who will not obey safety rules are not wanted. After he has been accepted and before he is assigned to work, he should be talked to on safety simply, and in a friendly way, by someone who knows the subject, knows men and can make himself readily understood. It is at this time that the new employe should be made acquainted with the general rules, not merely through receiving a copy of them, but by having them briefly explained to him. If the rules are in book form there is generally included a receipt form stating that the rules have been read, which is to be signed and turned in by the new employe. Sometimes, to supplement the verbal instructions, a printed message on safety is handed him (see Appendix).

While it should not require over 5 minutes to give the necessary preliminary instructions, the effect of which may save the employer days of the man's time, nevertheless they are frequently neglected, especially when new men must be taken on rapidly to meet rush conditions. This is, indeed, the very time when instruction is needed most to offset increased accident hazards and the poorer available grade of labor. Such instructions, however, if given at all, are often left to the judgment of an employment clerk and no check is made to ascertain the nature of the impression made on the new men. Nor should a stereotyped form of address be employed—the men who are intelligent and mentally alert will require less instruction than the foreign born and others who are slow to grasp the essentials of what is told them.

**Instructions on the Job.**—When the new employe takes up his work, it should be under the direct and almost constant supervision of a man who believes in safety, practices it and can lead other men, for it is from this man that the new employe must learn the *application* of the general safety principles that have been taught him at the employment office and those that he will gradually learn out of his safety rule book. This is frequently the precise point at which the system of safety instruction fails, for the foreman has probably been advanced to his present position on qualifications other than ability to teach accident pre-

vention. He may be a hearty believer in accident prevention and practice safety himself, but can he teach others a new point of view on the value of human life?

Few plants ever check this early instruction to ascertain its character or even its existence and, as result, the new employe is instructed in a very haphazard way, if at all. In many instances the new man's statement of his own ability and experience is taken at face value and he is merely "tried out," that is, left to prove whether he can get into trouble or keep out of it. At one plant an elderly man was employed on the mere statement that he had been a woodworker all his life. Without instruction or supervision the foreman proceeded to "try him out," by permitting him to operate a circular saw. Within a few hours he did something that no experienced sawyer would have done and cut all fingers and thumb off one hand. This accident cost the company $2,876, an amount which would have paid for a great deal of safety instruction.

Inability on the part of a foreman to give satisfactory safety instruction and maintain reasonable safety supervision extends beyond the hazard of the new man and affects all men and all physical conditions in his department. In fact, no man who cannot make his men safe men and cannot maintain safe operating conditions should be continued as foreman. Such deficiencies may at any moment cost his employers far more than his services are worth. Furthermore, it is probable that they extend beyond mere questions of safety and affect his proper functioning as an element in the production organization.

Many plants have apprenticeship plans or other machinery for systematic training of new men, and some employ special instructors other than foremen. The "buddy system" of putting the new man under the vocational guidance of an experienced operator of his own grade has met with success in classes of employment where it is applicable and is said to be instrumental in reducing labor turnover. The foreman, of course, retains his supervisory control. In some plants safety inspectors are made responsible for the instruction of new men in habits of safety, and even in small plants raw labor is assigned to the labor gang which is, in turn, drawn upon for recruits to fill operating vacancies where no great amount of skill is required.

The employe transferred to a different occupation undergoes some of the hazards to which the totally new employe is exposed

and therefore merits careful attention from his foreman. In the Appendix will be found a type of "Change of Occupation" card which provides means of checking the instruction of new and transferred employes.

**Effect of Employment on Accidents.**—With the knowledge that the new man in industry is more liable to accidental injury than employes who have had a year's service or more, we should expect to find some relation between general business conditions and injury frequency; that is, as business improved and new man accessions increased, injuries should increase, and *vice versa.* This is now generally admitted to be the case. In support of this hypothesis there has been reproduced in Fig. 7 a chart

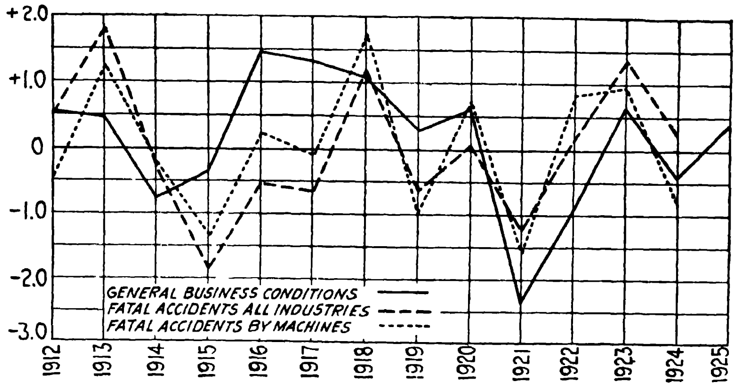


FIG. 7.—Fatal industrial accidents in relation to general business conditions. (*Metropolitan Life Insurance Company.*)

recently prepared by Louis I. Dublin, Statistician of the Metropolitan Life Insurance Company. The curve of "general business conditions" is a composite of important indices of general industrial activity as compiled by the American Telephone and Telegraph Company. The curves for "fatal accidents, all industries" and "fatal accidents by machines" are based upon the experience of industrial policyholders of the Metropolitan when expressed as mortality rate among white males, 15 years of age and older.

The relatively concordant variation of these curves is striking and seems adequately to support the opinion that industrial injuries increase with increased business. That such increase is not due solely to the effect of new man accessions is admitted.

Increased pressures for production, longer hours of work, individual derelictions arising out of the knowledge of "a sure job" may all be presumed to play their part. Increased employment, however, bringing its influx of new and inexperienced labor must be at least a major factor. It is obvious that at such times the instruction and training of newly acquired employes should be emphasized—unfortunately it is apt to be slighted and sometimes neglected altogether.

**Mechanization and the New Man.**—It was the application of the machine that revolutionized industry and brought the accident problem. The mechanization of industry is still going on at a rapid rate and will presumably continue as long as labor wage rates increase. In the first stages of the so-called "industrial revolution" it was the craftsman and artisan whose labor was replaced by mechanical appliances and, in the last decade or so, the semiskilled worker. In very recent years machinery for handling materials efficiently and cheaply has begun to replace common labor. Industry has, on the whole, profited enormously by these changes but, notwithstanding the safety movement, mechanical accidents have not decreased—in some states have even increased. The experience of the Metropolitan Life Insurance Company given in Fig. 7 shows a higher rate in 1923 than for any year save 1913 and 1918. How can we account for it?

Machine accidents may, in general, involve the regular attendant or, if they occur during repairs, a mechanic. Common labor, a large part of which is imported labor—imported into an industrial setting from the small towns or rural districts of this and foreign countries—is employed to a much less extent *at common labor* than formerly. Much of it is now employed operating, feeding or otherwise tending mechanical contrivances. Indeed, the fact that machines of various sorts can be operated by unskilled persons is the boast of their salesmen. They can be so operated, most assuredly, but the probability of injury is increased when persons with no mechanical experience or aptitude are put in charge of them. What does the young negro from the cotton fields or the Italian from a farm in the Apennines know of mechanical contrivances? In earlier years machine operators were mostly drawn from skilled or semiskilled labor, often Americans. This is not the case today.

There has not been an equivalent change in the type of mechanics who are called upon to make mechanical repairs, but

with an increase in the adoption of machines, there has been an increase in the number of repairs required. In one large plant, for example, the mechanical department has 25% of the payroll men. This in itself should make for increased accidents since repair work is inherently more hazardous than routine operations.

As for the hazard to machine operators and attendants, the only solution seems to lie in more adequate instruction and supervision, in better guarding of machines, especially at the point of operation, and in safety education and organization. The importance of proper instruction and training for such men has warranted the introduction of the subject into this chapter. It is a matter that should be given careful thought by all employers.

**Safety Atmosphere.**—The first impressions of the new employe, we may suppose, are vivid and apt to be retained. He is probably more influenced by what he sees than by what he is told. If he sees safety signs, safety bulletin boards, a safety rule book and various safety devices he will probably be somewhat impressed; if he is talked to on the subject of safety he will undoubtedly listen; but for final confirmation of what he has seen and been told he will look to the action of the men around him. He is, in fact, in a similar situation to the motorist entering a strange city who pays little heed to signs but patterns his actions on the local traffic.

If the new man sees other men disobeying safety rules, wearing their goggles on their caps, failing to adjust machine guards, not reporting minor injuries and otherwise taking chances, he will almost at once size up the situation and label his safety instruction "bunk," while if he has never worked in a plant where there was real safety work, it will be labeled "the same old bunk." In either case, he will likely apply his own standards of "safe" and "risky," provided he is capable of independent thought and action, otherwise he will merely do as others do. This is the negative of what we may term "safety atmosphere," that indefinable influence which pervades the industrial plant that is doing conscientious safety work and reaches, instinctively, even the new employe himself.

The atmosphere of carelessness, of disregard for human safety, is insidious, self-propagating and capable of undermining a vast amount of prolonged and expensive effort by the safety com-

mittees, safety engineer and the executives. It can render useless all the safety devices, warnings, bulletins and meetings that can be devised. It puts an effectual stop to accident reduction and makes no-accident records a sheer impossibility. It kills enthusiasm and takes the very heart out of the safety movement by making it an empty pretense and a subject for jest.

Not infrequently this atmosphere of carelessness has its origin in lack of interest in safety on the part of the plant's chief executive, of failure to understand the value of accident prevention or of unwillingness to lead the effort toward real results. In other words, he has not been "sold on safety." If such is the basic cause of the absence of safety atmosphere, he alone can remove it.

## CHAPTER XVII

## INHERENT AND POTENTIAL HAZARDS

Prevention of accidental injury from a recognized hazard may be sought through:

1. Protection.
2. Instruction.
3. Removal or reduction of the hazard.

In previous chapters, organization and prevention through instruction have been dealt with; some of the principles of protection and prevention by removal or reduction of the hazard will be discussed in this and the following chapter.

**Natural Laws.**—A clear conception of what must be *guarded against* is as indispensable as a knowledge of what must be guarded. To be satisfied merely to know the human body and how it may be injured is not sufficient—the effect of sudden, unrestrained or undue forces on man's physical structure—but the nature of the forces themselves and the natural laws governing their action must be understood. The necessity for this has been well expressed by Chester C Rausch:

> I have been impressed more and more by the fact that so many of the undertakings in industrial life, started with good intention and with every promise of success, have been found to be defective or have failed. The defects and failures have caused disaster, sometimes followed by serious accident and by death to individuals. Investigation following such disaster has shown the trouble has come about because in the planning and design of the undertaking too little recognition had been given to the fundamental laws of Nature that work inevitably and at all times, regardless of the persons or the materials that may be employed.
>
> One cannot tamper with natural laws or work contrary to them, and escape the inevitable action and result that follow. It makes no difference whether the law is one affecting the structure of the physical body or the materials or apparatus with which one works. Ignorance of these laws or the wilful neglect of them has made necessary laws and regulation for safeguarding the community as a whole and the creation of industrial commissions, engineers and inspectors and that vast number of people employed to make the existence of other people safe.

During my own experience I have been amazed to see what a number of simple natural laws that should be a part of the common education of every individual for his own comfort and protection are unknown even by persons having work to do that is concerned, either directly or indirectly, with the safety and health of other persons.[1]

**Inherent Hazards.**—Energy either manifested in a moving force or latent as *potential* energy—mechanical, electrical, or chemical in nature—is man's servant when under control but when unrestrained or misapplied is inherently hazardous to life. The casting suspended from the crane in midair has potential energy which, when released, is capable of crushing out life, if its mass and height combined are sufficient to produce an impact that the structure of human body cannot withstand. The human body upon an elevated platform or ladder possesses by virtue of gravity potential energy which, when converted into kinetic energy[2] as it falls, produces stresses on impact with the ground which may be too severe to be withstood. There is kinetic energy in the revolving flywheel, the force being exerted in the direction of rotation, as well as potential energy resulting from centrifugal force, which is converted into kinetic energy as the flywheel bursts.

The steam boiler under pressure has enormous potential energy, as has also the electric transformer, the generator and the "live wire." The stick of dynamite may be considered to possess potential energy, though not in the mechanical sense; it contains the necessary elements for rapid chemical decomposition during which heat is evolved and the resultant gases expend their potential energy through expansion. Acids and alkalis, on the other hand, can hardly be said to contain potential energy, but when brought into contact with the human body they are capable of setting up chemical action in which tissue is destroyed and heat evolved. Red-hot iron has thermal energy which is set free as heat through conduction, convection or radiation. Such heat may burn the body even without direct contact.

All forms in which energy is unexpectedly released or is misapplied are hazardous if the total amount of energy is sufficiently great and if its effects are brought to bear on the human body

[1] "Nature's Forces For and Against Workmen," *Safety Fundamentals*, Safety Institute of America, New York, p. 166, 1920.

[2] Kinetic energy is the energy of a body due to its motion through space. It is the product of the mass multiplied by the velocity.

in such a way that it cannot absorb or otherwise counteract them. These constitute true inherent hazards and they persist in spite of protective devices. The danger they create may be obviated, but strictly speaking, the hazard itself cannot be eliminated, although, as we shall see later, it can be reduced.

We must think not only of the hazard of direct application of energy to the body but also of the hazard created by its application to structures and equipment which, if they fail, will endanger human life. An overhead acid pipe line under pressure constitutes a direct hazard from leakage to a person passing beneath and, if the leaking acid is capable of starting combustion, a direct hazard to the building from fire; if the leaking acid is permitted to attack the building timbers, it directly endangers the structure and indirectly endangers its occupants.

**Obviating Inherent Hazards.**—More injuries from mechanical forces are due to violence of impact than to the crushing effect of sheer weight. The energy of impact varies directly with the mass (weight) and the square of the velocity. Thus, if the weight is halved, the impact is half as severe; if the velocity is halved, the impact is reduced to one-fourth.

Above certain undetermined limits any increase in impact probably makes little difference in its destructive effect on the human body. A fall from the roof of a 20-story building is probably, on the average, no worse than a fall from 10 stories, and the person struck by a train traveling 30 miles an hour has almost as little chance of survival as another struck by a train at 60 miles. Yet below these unknown limits there is undoubtedly some advantage to be gained from decreasing either the mass or its velocity—a person who is light in weight is less apt to be injured by a severe fall, the rupture of a small flywheel is less serious than that of a larger one, and small or low-speed belts are not as dangerous as heavy or high-speed belts.

We must also consider the ability of the human body to resist or absorb the action of forces. A man may drop 6 feet to a hard surface without injury because his body is "set" to absorb the impact, but if he falls this distance unexpectedly the rigid framework of his body may be so aligned that the shock cannot possibly be absorbed by his muscles, and an injury results. In baseball a player absorbs without injury the impact of a pitched ball that he is expecting, but the same ball may injure the player at the bat because his body is not prepared to receive its impact.

Obviously, when we decrease either mass or velocity, we lower the degree of inherent mechanical hazard. This, we may suppose, tends to affect injury severity rather than injury frequency; in other words, while the probability of being hurt through physical contact still persists, the injury itself is likely to be less severe. Yet there are conditions which do affect the probability of injury. In some instances material decrease in the velocity of a moving mass may permit an alert person to move out of the danger zone and so escape injury, as, for example, from in front of a moving train or an automobile. In some instances, it may permit others to utter a timely warning or, for example, effect the rescue of an employe whose clothing is already caught in moving machinery.

Decrease in mass *or* velocity permits more effective and rapid absorption of power and therefore quicker stopping by means of brakes, as in the case of moving vehicles and such machinery as rolls, calenders and wringers. Whether quick-stopping devices are operated automatically or by human agency the time required to actuate the device is an important factor but, aside from it, stopping will be effected relatively more quickly as the speed or mass of the machine is lowered.

Certain types of protective devices will function with greater certainty in their respective fields when the velocity or mass is decreased. Goggles or shields used as protection against flying fragments are examples of this, as are grinding-wheel enclosures and guards erected for protection against breaking belts. In mechanical and electric power transmission, a serious injury to someone caught in a driven machine may be averted by the slipping of a belt or the opening of a fuse or circuit breaker if the overload capacity of the transmission is not too high.

**Limitation of Potential Hazard.**—Just as in the case of kinetic energy, there are advantages to be had from keeping the potential energy as low as practicable and this is true whether the energy is mechanical, electrical, thermal or chemical. In the field of engineering design, when choice is permissible, selection should be made of the lowest practicable height, operating pressure, velocity, voltage, temperature or chemical strength, as the case may be. In the long run, resulting injuries will be less severe. Furthermore, proper factors of safety will be more readily attained and more surely maintained in the face of natural wear, deterioration and repair; safety devices intended to prevent

sudden and wholesale release of potential energy will be, on the whole, less complicated and more dependable. It is often in this way that the chance of the occurrence of a catastrophe, involving severe structural damage and possibly the death of a number of persons, is minimized.

By way of illustrating the preceding paragraphs, the following practical examples may be cited of hazards that have been diminished by decreasing the potential energy involved:

1. Rearrangement of building contents to decrease floor loads on upper floors of old buildings.
2. Replacing line shafting and belt drives on dough mixers with individual motor drives.
3. Installing automatic circuit breakers on feeder circuits not previously equipped with breakers or fuses.
4. Installing non-return valves on boilers.
5. Substituting water-tube boilers for return tubular boilers.
6. Replacing gravity-flow gasoline supply system with sub-surface gasoline storage tanks and pumps.
7. Erecting service magazine for storage of explosive to obviate practice of bringing a day's supply to the workings.

A little thought will convince the reader that in each of these examples the total energy that would be liberated in event of some failure has been reduced and, while the failure might never occur, the potential hazard has been decreased.

Lessening the hazard by reducing the pressure, velocity, voltage, temperature or chemical strength factor is illustrated by the following examples:

1. Reducing steam pressure on cast-iron radiators formerly operated on full boiler pressure.
2. Lowering speed of grinding wheels to conform with manufacturer's specifications.
3. Replacing 550-volt series lighting system with 110 volts.
4. Changes to fire wall and baffles of autoclave which was formerly overheated and weakened.
5. Substitution of kerosene for gasoline, or toluol for benzol, in cleaning or removing grease.
6. Purchase of weak acid for use in pickling bath instead of strong acid to be later diluted.

These are typical instances which have come under the writer's observation. In each case the inherent hazard was reduced by the changes made, but the results are not the same as those

attained by the changes in the preceding list. In the former, the aggregate hazard was reduced by limiting the total energy that could be liberated when an accident occurred, but the probability of accident occurring was not directly affected. In the latter series of examples both the potential energy and the probability of accident have been reduced.

Often changes such as the above are not made primarily to secure safer conditions but take place in the course of normal industrial development. Because of their fundamental importance, these matters deserve the closest study when a plant is in the planning or design stage, whether the manufacturing process is a new one or is merely being improved upon or added to. This in itself is sufficient excuse for requiring design engineers to pay adequate attention to the demands of safety and for maintaining close working contact between design engineers and safety engineers.

Although many changes such as those cited are most economically incorporated in the original design of a plant—and some are practically out of the question after the plant has been built—the author by no means desires to convey the impression that there is no opportunity for effecting such changes in an operating plant. On the contrary, many opportunities for reducing inherent hazard exist in every operating plant. Furthermore, even if safety were given careful consideration in the original design, gradual changes in operating conditions and modifications of the plant and equipment may have increased the inherent hazards to a greater extent than has been appreciated.

**Electrical Hazards.**—In industrial utilization of electric power there are presented many opportunities for decreasing the potential hazard. The dangers inherent in "the live wire" are known to all. Insulation, enclosed switches and, for the electrician, rubber gloves, protectors and insulated tools are the familiar safeguards which prevent simultaneous contact with live parts having enough difference of potential to send current through the body sufficient to cause injury or death. The contact resistance of the body itself is a safeguard of enormous importance—if we lower it sufficiently as, for example, by moistening the hands, a shock from the ordinary lighting circuit may result fatally.

A large number of fatal electrical accidents, however, are the result, not of simultaneous bodily contact with two live portions of the electrical equipment between which a difference of poten-

tial exists, but of contact with one live part, or with a metal part that has become unexpectedly "charged," and with the ground. An employe, totally unaware of the hazard, touches the frame of a motor, the handle of a motor-starter, or sometimes merely the metallic wall of a building and drops in his tracks. This is the hazard of the grounded circuit familiar to all who have studied electrical accidents.

The hazard is due to the simultaneous existence of two conditions: (*a*) electrical contact through touching either a live part or a metal part which is grounded, that is, which has established connection (usually by the breakdown of insulation) with one side of the circuit; and (*b*) some path by which current from the opposite side of the circuit may flow to another part of the victim's body.

Moist earth, buried pipes and tracks usually form the greater part of the latter path but there is a gap at either end which must be bridged. At the end from which the electricity is supplied the "bridge" may consist of another ground or break in the insulation, perhaps a short-circuited lightning arrester, a defective transformer or merely the electrostatic capacity of the system itself. Usually it consists of a variety of minor leaks all contributing to create the condition known as a "grounded system." Be it said that industrial electric systems *are seldom free from a number of high-resistance grounds*, which, functioning in multiple, may act as a single low-resistance ground.

The "bridge" at the victim's end of the path is fortunately more difficult to establish. It is usually a wet floor plus wet or worn shoes. Sometimes his wet shoe or some poorly insulated part of his body comes into direct contact with a metal object that is in turn connected with wet ground or a water pipe. In the domestic bathroom tragedy the victim is usually in the bath tub, or his hand in the filled basin, or he is touching a faucet.

In seeking to prevent accidents from grounded circuits in industrial plants it is customary to ground artificially electric conduits, switchboxes, the frames of motors and other metallic parts of electric equipment not intended to carry current. The intent of this is to provide a much better path for the current than the human body in case the insulation should break down and cause a ground. A better path is often provided in this way but sometimes it is not of sufficiently low resistance, as, for example, when a ground wire is poorly connected to a water pipe

PLATE XIII.—Modern Machine Shop—(note orderly arrangement, aisle marking, absence of overhead drives and satisfactory lighting). (*National Safety Council.*)

(*Facing page 164*)

Plate XIV.—Well-arranged Tool-room—Cleveland Automatic Machine Company. (*National Safety Council.*)

(*Facing page 165*)

becomes broken, or when the ground itself is merely a plate buried in dry soil or a piece of pipe driven into the ground. Employes have sometimes been electrocuted when standing within a few feet of such a ground.

There is an effective way to remove the greater part of the hazard which, however, one seldom sees employed. It consists of providing a definite metallic path leading from one side of the electric circuit to every non-current-carrying metal part of the electrical equipment. This is effected by ground wires from such parts to the water pipes plus a substantial connection between one wire of the power supply, or (preferably) from a "neutral point," to the water system; in other words, in place of a quasi-grounded return a reliable ground return is substituted, and in place of a quasi-grounded power system a permanently grounded system. The result of this arrangement is that the accidental grounding of any part of the electrical equipment, through insulation failure or otherwise, instead of setting up an inherently hazardous condition which may maintain for months, jeopardizing lives and property, is instantly followed by the opening of fuses or circuit breakers in the circuit supplying the defective equipment, thus temporarily removing the hazard and at the same time giving ample warning of its existence.

It seems surprising that this comparatively simple and inexpensive expedient has not been more generally adopted in plants with isolated sources of electric power and especially those which have a number of operating buildings and complicated electrical equipment. At least one large corporation has adopted it with very satisfactory results. It should, of course, be intelligently applied and only on the advice of a competent electrical engineer and with the approval of the underwriters.

The reader will note that the grounded circuit is essentially a hazard brought about by equipment failure, usually through the breakdown of insulation. Inspection, tests for insulation resistance and proper maintenance will go far toward obviating its occurrence, but of even greater importance, in the beginning, is the technically correct installation of first-class equipment, including wire with reliable insulating properties.

**Engineering Revision.**—The correction or reduction of the hazard at its source, through what was first termed by Lucian W. Chaney "engineering revision," but which includes engineering prevision and supervision, is fundamentally the only sound

method of actually preventing accidental injuries. It is not, however, applicable to all conditions of accident causation or to all types of hazards. It is usually the most expensive method in first cost and often the slowest to effect, though these disadvantages are apt to be offset by greater advantages, of which safety is but one. Its application is conditioned to a great extent upon the building up of a high degree of interest in safety in those in executive authority (so that they will be willing to authorize the expenditures entailed) and upon the stimulation of the engineering staff to the point where engineering prevision, supervision and revision for safety become an admitted part of their duties and are given serious attention.

In this branch of accident prevention resides the greatest possibility of reducing injury severity and eliminating accidents of the magnitude of catastrophes. To what ultimate degree injury severity can be so reduced, it is impossible to say, but the possibilities seem almost unlimited.

> Revision offers the engineer a still larger field of activity than either safety education or the application of safeguards. It is more fundamental, requiring more expert knowledge not only of certain operations, but also of entire processes. It often involves the installation of new equipment, improving and refining present equipment, and redesigning various processes.[1]

To illustrate what engineering revision is capable of accomplishing the author submits two examples taken from the experience of the duPont Company during the war period, one having to do with the inherent hazards of smokeless powder (single base nitrocellulose) in the process of manufacture, and the other involving the acute and chronic poisoning hazard present in the process handling of crude and refined trinitrotoluol (T.N.T.). This experience is shown in Tables VIII and IX.

Both the materials in question possess a high degree of potential hazard which cannot be itself eliminated. Indeed, in the case of smokeless powder, it will be noted that the amount accidentally destroyed by fire actually increased from year to year. Largely through fundamental improvements in both operating processes, the fatality and injury rates, respectively, were materially reduced as means were discovered whereby the poten-

[1] "Report of Committee on Safety Education in Engineering Colleges," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, **1**, p. 203, 1925.

TABLE VIII.—ACCIDENT EXPERIENCE IN MANUFACTURE OF SINGLE-BASE NITROCELLULOSE SMOKELESS POWDER; E. I. DUPONT DE NEMOURS AND COMPANY

| | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|
| Smokeless powder production, pounds | 220,187,753 | 593,360,473 | 755,612,108 | 770,549,605 |
| Destroyed by fire, pounds | 296,071 | 607,398 | 843,845 | 2,190,988 |
| Per cent of total production | 0.13 | 0.10 | 0.11 | 0.32 |
| Fatalities from fire | 19 | 43 | 8 | 2 |
| Fatalities per million pounds production | 0.086 | 0.073 | 0.011 | 0.003 |
| Fatalities per million pounds destroyed | 64 | 71 | 9.5 | 0.8 |

TABLE IX.—ACCIDENT EXPERIENCE IN TRINITROTOLUOL MANUFACTURE AND HANDLING; E. I. DUPONT DE NEMOURS AND COMPANY

| | 1914 | 1915 | 1916 | 1917 | 1918 |
|---|---|---|---|---|---|
| Total weight handled, pounds | 1,972,477 | 12,123,105 | 37,204,436 | 43,247,090 | 91,047,717 |
| Number of tabulatable poisoning cases | 60 | 151 | 24 | 2 | 2 |
| Cases per million pounds | 12.1 | 12.5 | 0.65 | 0.05 | 0.02 |
| Hours lost per million pounds | 398 | 185 | 31 | 5 | 1 |

tial hazards could be somewhat obviated and the exposure to injury diminished. If this was possible with materials so difficult to handle safely, under troublesome labor conditions and in the stress of war activities, is it not also possible to overcome to a considerable extent the potential hazards of materials and processes infinitely less dangerous which are encountered in the average industrial establishment?

**Factors of Safety.**—It is not within the province of this volume to enter into discussion of the selection of appropriate factors of safety to be used in engineering design or specified in purchase, and for information on this the reader should consult the textbooks of authors who are recognized authorities in their branch of engineering. The subject, nevertheless, is of vital importance in its relation to safety from inherent hazards involving relatively dangerous amounts of potential energy.

It by no means suffices that factors of safety are intelligently selected and applied when a structure or its equipment is originally designed, but the conditions of use must be observed closely and, above all, the effect of deterioration caused by overloads,

unbalanced loads, repeated stresses, overheating, frost or freezing, electrolysis, dry rot, mechanical wear, corrosion, erosion, decomposition, and many other elements which tend to weaken structural materials and shorten their useful life. Many of these natural processes operate slowly and their effects are sometimes difficult to detect; consequently they are often overlooked and it is taken for granted that the building or equipment is as safe as when erected or purchased.

Deterioration often results from neglected maintenance, even of the simplest and most obvious kind, as well as from downright abuse. More will be said of this in subsequent chapters but the author desires to emphasize here that neglected maintenance is often the end-result of poor factory management or false economy, sometimes superinduced by business depression. It is particularly prevalent in processes that are difficult to keep clean and orderly or where the rate of deterioration from normal use is high—as in the chemical industry. One should also look for defects of this kind after periods of prolonged shutdown during which buildings and equipment have remained idle, in buildings and equipment that have been previously used for other purposes or have been purchased second-hand, and in plants where general housekeeping is poor or which exhibit evidences of unskilful or makeshift repairs.

In connection with this subject, it may not be amiss to call attention to the effect on repairs of the use of portable welding equipment by mechanics who have scant knowledge of the proper requirements for the job. Welds may be made which appear superficially excellent but which, below the surface, are wholly unsatisfactory and dangerous. Those who have supervision over such matters would do well to familiarize themselves with the inspection practice of established firms manufacturing welded products upon the excellence of which their business reputation depends.

Where possible failure of pressure vessels, such as boilers, autoclaves, receivers and other closed receptacles, is the hazard involved, the provision, maintenance and testing of pressure relief devices is of major importance since they are the safeguards against rupture from excess pressure. The technique has been standardized, so far as the commoner forms of pressure vessels are concerned, and the reader is referred in particular to the *Boiler Construction Code* of the American Society of Mechanical Engi-

neers, and to the local requirements of the state and municipality in which his plant is located. In the chemical industry many new forms of pressure vessels have come into use, sometimes involving conditions under which ordinary pressure relief devices cannot be employed. A discussion of this subject will be found in *Safe Practices Pamphlet* 68 of the National Safety Council. Internal and external inspections, shell measurements and hydrostatic tests, which are employed as an additional safeguard, are all important though perhaps not as vital as good engineering design, intelligent operation and the provision of reliable relief devices.

**Mechanical Hazards.**—In many instances where inherent hazards cannot be obviated or reduced, it is often possible to prevent or at least retard the fulfillment of one of the antecedent conditions essential to the consummation of an accident. When a pair of spur gears, for example, is completely enclosed in a sheet-steel guard, the inherent hazard in the moving gears is neither eliminated nor obviated, but accidental injury is rendered improbable by precluding the fulfillment of one of the necessary conditions—bodily contact with the moving teeth.

The primary function of mechanical guarding is, in fact, the prevention of accidental contact with what is inherently dangerous. One of the earliest lessons learned during the pioneer days of the industrial accident prevention, however, was that only about one-third of the injuries could be prevented by the installation of safety devices such as railings and guards, and, in the present day, it is undoubtedly true that, although considerable advance has been made in the field of mechanical guarding, mechanical accidents are still rather frequent even on well-guarded plants. The relative ineffectiveness of this branch of safety work is probably due to the impossibility of detecting all points at which a mechanical accident might occur, the impracticability of completely guarding all recognized points of danger and the lack of complete reliability in the guards themselves. It has long been recognized that guards cannot be made "foolproof."

Exposure to injury from contact with mechanical hazards may be arbitrarily classified in three groups as follows:

1. Expected men in expected situations.
2. Expected men in unexpected situations.
3. Unexpected men in expected or unexpected situations.

If we select as example the drill presses in a machine shop, the first group is represented by machinists operating drill presses

in a normal way. The second group is composed of machinists operating drill presses abnormally. The third group consists, not of machinists, but of men who have no business to operate drill presses. Injury frequency in the first group will be low because the men are skilled, their actions are routine, the hazards may be anticipated in advance and effective safety devices may be designed and kept in place. The frequency rate for the second and third groups will obviously be high.

What the author desires to emphasize is that by far the greatest number of mechanical injuries (and also injuries from falls) are the direct outcome of experienced men performing unexpected or unsuspected acts and of inexperienced men getting into situations not anticipated by the management. No one can say how many investigations of unnecessary injuries have been laid at rest with the statement "he was not expected to go there" or, "he was not expected to do this." Because such acts are not anticipated there is but little opportunity for prevention through protective devices, the basic remedy for such situations being intelligent men, careful instructions, good discipline, the safety spirit and that fundamental safety design which lessens the chances of the happening of the unexpected.

**Fundamental Safety Design.**—By this is meant the fruit of an engineering prevision that is able to conceive and satisfy the requirements of safe equipment and safe conditions of production and maintenance. It is, in fact, the essence of sound engineering judgment and from it arises not only safety but production efficiency. Efficiency demands orderliness and permits routine, while the unexpected, either in men or situations, destroys order and, in so doing, creates conditions conducive to accidents.

Fundamental safety design requires of the engineer not only a prevision of the building, its equipment and the functioning of the production process but of the positions and actions of the men employed; in fact, he should be able to forecast the human exposure to injury and be as zealous to minimize it through design as he is to reduce the waste of power, material, product, or any other losses which affect production cost.

It is impossible within the scope of this treatise to cover adequately this branch of safety work and it must suffice merely to list some of the more important points that should be given consideration, realizing that, as is usual in engineering experience,

the final design will be in the nature of a compromise to meet conflicting requirements:

1. Ample space around individual machines or process units for normal operation, adjustments, usual repairs and for materials supplied, in process and completed.

2. Logical arrangement of units in sequence so that the process flow is as direct as possible, with the minimum intersection of aisles or other general routes upon which human exposure is relatively high.

3. Selection of process units of correlated size so that the piling up of process material between units is minimized and it is not necessary to crowd work on some units while others are standing idle.

4. Installation of sufficient units of each kind to permit necessary time for ordinary repairs, adjustments, etc., without curtailing production as a whole.

5. Provision of an efficient, safe and flexible system for moving materials in process, bringing up supplies and taking away finished materials. (For safety and efficiency this should be designed to reduce as far as possible the number of foot-pounds handled by hand per man per day, hand-handling being essentially inefficient and constituting one of the greatest general causes of accidental injury. Trucking and similar hand transportation, where necessary, should be done by truckers and not by men otherwise employed.)

6. Ample and convenient provisions for storing, packing and warehousing, with means of mechanical transportation, tiering and car loading. (As far as possible, high storage should be avoided.)

7. Provision of ample and direct aisles, stairs and other thoroughfares free from obstruction by materials, machines, piping, conveyors, belts, tracks and other potential hazards. Central location for elevators, toolrooms, washrooms and toilets. Provisions for rapid exit in case of fire.

8. Power system with minimum potential energy exposure and with minimum mass and individual exposure to human contact. (From the safety point of view the medium voltage individual motor drive is to be preferred.) Provisions for safe and convenient inspection, repairs and oiling. (For the latter, the use of portable ladders should be made unnecessary.)

9. Provision of means for safe and quick cut-off of mechanical or electric power, steam, liquids, etc., not only at the individual machines or process units but, in emergencies, from the rooms or buildings. (Inseparably associated with this is the proper location of main supply lines and important points of control, such as switchboards and main valves, so that they will be at all times readily accessible but comparatively immune from damage by the breaking of a belt or valve, a sudden fire or other emergency in which their operation is of paramount importance.)

10. Proper ventilation, heating and air conditioning; mechanical removal of dust and noxious vapors, fumes and steam at the source. (The need of respirators should be overcome and, as far as possible, of dust goggles or masks.)

11. Good lighting, both natural and artificial, not only at machines and process units but in storerooms and warehouses, along aisles and thoroughfares, on stairs, elevator shafts and, in fact, everywhere where employes go. (For special and emergency use, provision should be made for safe extension lights by installing proper attachment facilities independent of the regular lights.)

12. Provisons for proper housecleaning, removal of waste, scrap and rubbish, emptying of wastecans, floor and window cleaning, cleaning of washrooms, toilets and locker-rooms.

13. Careful routing of outside traffic, both pedestrian and vehicular, with avoidance of intersections and crossing of railroad tracks and motor-car routes by pedestrians, elimination of blind corners as well as congestion caused by trucks, cars or trains while loading, unloading or switching; provision of parking facilities; proper lighting, paving and grading of thoroughfares.

It is naturally difficult to prepare general suggestions that would be of value to the engineer in all plants and the foregoing should be considered suggestive rather than specific. They are mainly applicable to new plants, but are of possible application to existing plants in view of the fact that there is often a lamentable tendency to crowd additional equipment into buildings already congested or poorly adapted to the purpose for which they are used.

Many other helpful suggestions can be derived from the long list given in *Safe Practices Pamphlet* 53 "Checking Plans and Specifications for Safety," of the National Safety Council.

**Design to Lessen Falls.**—Provision for the safe movement of persons about their work, touched briefly in item 7 of the preceding list, is a matter of extreme importance. An authority on accidents from falling tells us:

It should be noted that in less than 10 years more of our people are killed by everyday accidental falls than our total killed . . . in all wars since the founding of the United States, nearly 150 years ago. The yearly average is approximately 14,000. All "falls" are not caused by unsafe walkway surfaces, but nearly half of them are from that source, or approximately 7,000 per year . . . In the first place, it must be appreciated that the slipping hazard gives no warning of its presence. The whirring belt or the noisy gear of themselves give warning, but not so with the slippery surface. Signs may be displayed such as "Watch Your Step," or "Be Careful," etc., but so long as the hazard is permitted to remain, accidents from slipping will continue. Therefore, if progress in this direction is to be made, the methods of providing safe walkways must be considered.[1]

The time to apply appropriate preventive measures against accidents involving falls is during the design stage. This is so obvious that no further comment seems necessary. Nevertheless, other conditions must be borne in mind, also subject to engineering revision, which make for the occurrence of accidents of this sort, even though they may appear to have only a remote connection with the situation. There is, for example, an obvious relation between haste and falls. An interesting case is related of the prevention of injury to women employes from falls caused by the heels of their shoes catching as they descended the stairs at noon. The remedy applied did not relate to their shoes or to the stairs, but consisted of an addition to the lunchroom which was formerly overcrowded. This removed the incentive to hurry and the accidents ceased.

[1] Mowery, H. W., "Safety on Walkways, Floors, Etc.," *Annals of the Am. Academy of Political and Social Science*, **123**, 212, p. 156, 1926.

## CHAPTER XVIII

# PROTECTIVE PRINCIPLES

While there should be a continuous effort to obviate or diminish accident hazards by attacking them at the source, a very great number of situations can be taken care of only through the application of protective principles, that is, by protecting the employe from contact with what is dangerous. We shall term such means of protection "safety equipment." In this category are included safety devices that are fixed or applied to buildings or equipment and those that are carried or worn by the employe. For the sake of distinction, we shall call the former "safety appliances" and the latter "personal protection."

**Information on Safety Equipment.**—It is not the intent of the author to enumerate the various purposes and types of mechanical guards and other safety equipment or discuss their design and application. Rapid progress is being made in standardization. The birth rate of "freak" devices is on the decline. Ready-made, purchasable equipment is more practicable, reliable and durable than ever before. There are a number of reliable firms specializing in safety equipment, some of which not only furnish ready-made safety appliances and devices for personal protection but undertake contract work for the fabrication and installation of power transmission and mackine guards, designed by competent men familiar with state, insurance and practical requirements. As a rule, such guards are substantially built and are often cheaper and more satisfactory in the long run than those made by plant mechanics or the "handy man" of the small plant. Needless to say, the day of the flimsy, knocked-together guard, constructed of wood or tin, has passed.

Whether safety equipment is purchased or homemade, the plant manager, safety committee chairman and safety engineer need to know:

1. What is required by state law or regulation.
2. What is demanded by the insurance company or will affect the compensation insurance rate by its presence or absence.

3. What is accepted good practice.

**State Requirements.**—The state requirements may be ascertained by addressing the state department of labor. Some states can supply copies of codes or regulations but in others no codes or regulations exist. Inspection by a state inspector may be properly requested. In some states a thorough inspection will be made periodically, in others an inspection made on request or after a serious accident will be a cursory examination, in other states there exist no provisions for making industrial safety inspections.

Whatever the local situation, cooperation with, and not opposition to, the state's officers should be the rule and its safety regulations (such as they are) or orders for changes should be cheerfully complied with. In some states the employer may be penalized when injury has resulted from non-conformance with safety regulations. All states have broad police powers which may be employed to remedy conditions affecting adversely the safety of their citizens and such powers are vested in the local departments of labor to be employed within their jurisdiction.

The commissioners of labor are, as a body, sincerely interested in accident prevention and have a national organization, the International Association of Industrial Accident Boards and Commissions, which is doing a large amount of constructive work. As individuals, functioning in their separate states, their ability and the scope and limitations of the preventive work that they are able to carry on naturally varies. In some states it is of a very high order of excellence. Correction of hazardous conditions is sought through educational rather than mandatory methods. The author's observation has been that employers who indicate their complete willingness to cooperate with the state department and demonstrate their personal interest in safety get into no difficulties from this source and may derive much help.

The reader should realize that industrial accident prevention in this country had its early beginnings in state activities. Massachusetts, the pioneer in this respect, appointed factory inspectors in 1867 and in 1877 enacted a law requiring factory safeguards. The essentially industrial states have continued to contribute enormously to industrial accident prevention and will always do so.

To illustrate the effect of state requirements on the accident situation (in combination, of course, with other influences

simultaneously at work) we may refer to the Massachusetts experience in reported accidents from gears. There were 934 such cases in the year ending June 30, 1918, constituting 12.1% of the total tabulatable injuries reported. The state regulations requiring the guarding of gears became operative March 20, 1918, and the number of injuries from this source decreased consistently to a minimum of 359 for the year ending June 30, 1924, in which year they represented 5.8% of the total tabulatable injuries reported. This was a net decrease of 52% in 6 years. Such a reduction also reflects the effectiveness of gear guards as a protective measure.[1]

**Insurance Requirements.**—Liability insurance companies are not only glad to give information on protection but many include periodic safety inspections as part of their regular service. The computation of quoted insurance rates is not based on the judgment of inspectors nor is it governed by competitive conditions, as many believe; it is based on uniform standards of classified manual rates derived from mass loss experience. These rates may be modified or even superseded by the actual loss experience of the plant in question (experience rating) or by "credits" or "charges" for its physical condition and preventive work computed in accordance with a standard schedule (schedule rating).[2]

Under schedule rating the normal range of rate modifications varies from reductions of 40%, to increases of 40% on manual rates. In a few instances it has reached 60 to 65%. The experience rating modifications, which are additional to those obtained through schedule rating, sometimes run as high as 50 to 55% in credits and have been known to reach 160% in debits, though the latter figure is extraordinary.

The whole process of rate making is under direct supervision of state authorities and the possibility of irregularities is reduced to a minimum. There is, therefore, no reason for insurance companies to refuse information and they always recognize the importance of assisting their policyholders to better their accident experience. The insured, for their part, should familiarize

themselves with rating methods and avail themselves of the substantial credits that safety organization and accident prevention are capable of securing for them.

In the past, there has been a disposition on the part of some to regard the interest in accident prevention of the companies writing liability insurance as biased by business considerations. Gratifying changes in this attitude, however, have been taking place. The employers, on the one hand, have come to realize that the insurance companies can and will furnish substantial help in preventing accidents, and the companies, on the other hand, believing that their obligation extends beyond the mere settlement of claims and into the preventive field, not only are willing to assist the employer in his safety work, but have done much to further the safety movement nationally. To this end they have contributed to no slight extent, but without attempting in any way to preempt or dominate the field.

There are a number of books on the subject of liability insurance containing specific information on rating and also on accident prevention. The *Industrial Compensation Rating Schedule,* issued by the National Council on Compensation Insurance, New York City, contains much information that is useful to the safety engineer, especially on the guarding of machinery.

**Safety Standards.**—There are many sources from which good, accepted safety practice may be learned. The most authoritative standards are those that have been worked out by broadly representative committees under the sponsorship of recognized national bodies in accordance with the rules of the American Engineering Standards Committee.

The preparation of safety codes by the American Engineering Standards Committee is under the immediate control of a committee of safety engineers, known as the "Safety Code Correlating Committee." The way in which the actual work is done is thus described by P. G. Agnew, the Secretary:

> The work on individual projects developed under the procedure of the American Engineering Standards Committee is carried on in joint technical committees (officially called "sectional" committees), such as the committee for the safety code for grinding wheels, on which committees all the interests concerned in the standard are represented. In the case of safety codes this comprises the following groups:
>
> 1. Manufacturers (makers of the equipment).
> 2. Employers (purchasers, owners, users of the equipment).

3. Employes.
4. Governmental bodies having regulatory power or influence over the field in question.
5. Qualified specialists, such as staff representatives of technical societies, consulting experts with no exclusive business affiliation and educators.
6. Insurance representatives.

Thus, the work of drawing up national safety codes is in the hands, jointly, of those who are responsible for the administrative and legal aspects of the problems involved, of those who have to face the technical, industrial and financial sides of the problems, and of those who have to face the hazards to life and limb.[1]

These codes are finally promulgated by the American Engineering Standards Committee as "American Standards" or "Tentative American Standards." They may be accepted as authoritative and, at the time of promulgation, represent the latest and best practice. They are recommended by the author for reference and adoption as applied to industrial plants.

A list of American Standards and tentative standards relating to accident prevention, as completed and promulgated up to July 1, 1925, will be found in the Appendix. Full information on safety code work is to be found in the *Year Book* of the Committee. This and copies of the standards may be obtained (at nominal cost) from the American Engineering Standards Committee, 29 West 39th Street, New York City.

As a source of general information on safety equipment and practice, almost indispensable to the safety engineer and executive, there are the *Safe Practices Pamphlets* issued for the use of its members by the National Safety Council, many of which are devoted to the subject of protection, general, as well as specifically applying to certain industries. These do not prescribe precise standards but set forth accepted practice in accordance with the experience of the engineers on the staff of the Council and its members. Before promulgation, these pamphlets are reviewed by a selected body of 75 safety engineers. They are brief, clear, up to date and are illustrated with photographs showing actual conditions on operating plants. They are sold at nominal cost. The published *Proceedings of the National Safety Council* also contain many papers in which safety equip-

[1] "The National Safety Code Program," *Annals of the Am. Academy of Political and Social Science*, **123**, 212, p. 51, 1926.

ment is described and discussed. From time to time reports on various phases of protective work are rendered by special committees of the American Society of Safety Engineers-Engineering Section of the National Safety Council.

Much information on protection can be gleaned from the rule books of corporations that have been among the pioneers in safety work, especially the United States Steel Corporation. The Travelers Insurance Company has issued some excellent pamphlets on grinding wheels, elevators, boilers, reciprocating engines, turbines, machine shops, foundries, power presses and building construction. Among the textbooks, of which there are not many, "Industrial Accident Prevention"[1] by David S. Beyer contains a large amount of excellent information on accepted safety practice.

Safety engineers of industrial concerns, manufacturers of safety appliances and state and governmental authorities are generally willing to furnish gratis all the information at their command including such standards as they have developed. This readiness to help solve the problems of the newcomer in the field of organized accident prevention is one of the most inspiring aspects of the safety movement, and one quality which has contributed largely to its marvelous development in this country.

**Requirements for Safety Appliances.**—The general requirements for guards and similar safety appliances may be briefly stated:

1. *Maximum Protection.*—Protection afforded should be complete and continuous. It should protect absolutely even the careless and thoughtless. Not only should it protect the regular attendant but also the oiler, mechanic and others who may be in the vicinity. It should not be necessary to disturb it during the course of lubrication, ordinary adjustments, cleaning and other routine procedure. To accomplish this it is generally necessary to design guards so that bearings are external to them and therefore easily accessible for lubrication or handling to test temperature. Group guards, that is, guards enclosing more than a single drive, shaft or train of gears tend to defeat this purpose; hence a large number of small individual guards are usually preferable to a single, extensive enclosure. Open railings applied for this purpose are not dependable.

2. *Non-interference.*—Protection should be designed to avoid interference with work that should be performed while the machinery is in

[1] Houghton Mifflin Company, Boston.

operation. The operation of machinery, therefore, should be as far as possible visible through the guard. If guards must be hinged or provided with gates in order to permit access within while the machinery is in operation, complete protection is not afforded. If such provisions are indispensable, the openings should be ample and it is better that the gates should not be self-closing. Guards applied to or close to the cutting points or edges of machine tools and woodworking machines and to "the point of operation"[1] of other equipment should be readily adjustable and also readily disengaged to permit tool setting or other normal adjustment made while the machine is not in motion. Such guards should interfere as little as possible with a clear view of the work, especially if it must be done to line or otherwise requires accurate adjustment by hand while the machine is in motion.

3. *Strength.*—Protection should be strong enough to withstand ordinary impact with a reasonable factor of safety and with due allowance for expected wear and tear and frequent removal for major adjustments or repairs.

4. *Simplicity.*—Protection should be as simple as possible, with an entire absence of complicated mechanical features making for uncertainty of operation or difficult adjustment.

It is not always possible to satisfy all these requirements to the fullest extent and the ideal guard is yet to be designed. The engineer, however, should not merely set out to apply "a guard," but rather strive to design and apply the most effective guard that conditions will permit. To attempt to do this without full knowledge of the process and the functions of the machine and its attendants would be folly. Even with this knowledge, he must give the subject careful thought and the benefit of discussion with others.

Much excellent information on the construction of guards will be found in the National Safety Council's *Safe Practices Pamphlet* 58, " Construction of Machinery Guards." For belt drives, exposed shafts and the larger gears, guards of expanded metal on angle iron frames, welded instead of bolted or riveted, are to be preferred on the basis of first cost as well as durability. Cast iron or sheet metal, solid or perforated, is used for guarding comparatively small gears and pulleys. For the use of wood there is no justification, even in the case of open railings, except

[1] The Industrial Compensation Rating Schedule defines *the point of operation* as "that part of the machine where stock is actually inserted and maintained during any process of forming, shaping or other necessary operation."

for temporary protection or where metal will not withstand chemical action. Wooden guards are insecure, uncertain, a fire hazard and, in the long run, far from inexpensive to maintain.

**Defects in Protection.**—The most conspicuous shortcoming of the guards that one usually sees is their comparative flimsiness. To skimp strength is false economy, leading to short life, high maintenance costs, doubtful security and indirect encouragement to employes not to replace them when removed for the purpose of making repairs or adjustments. That a safety device merits a more ample factor of safety than any other type of equipment does not seem to occur to the average engineer or construction man. Indeed, he is apt to approach it as an afterthought and treat it as an adjunct; as result, its very appearance militates against its continued use.

The larger manufacturers of machine tools and many builders of process machines now equip their product with substantial guards, but in some cases it is necessary to specify their inclusion on the purchase order and pay an extra charge for them. Usually guards furnished and applied by the manufacturers are all that could be desired, especially if regularly furnished as a standard part of the equipment. If they are included as an "extra," however, the purchaser would do well to ascertain in advance just what he is getting, since they may not have been designed with engineering skill to form an integral part of the machine, but were left to the judgment of a shop foreman or mechanic to lay out and construct.

While it is customary in large corporations to have the purchasing department specify the inclusion of the usual safety devices when securing bids on machinery, it is evident that the follow-up to ascertain just what is to be actually provided on the purchased machines must be done by persons with technical knowledge and experience—the engineering or safety department. In any event, the purchaser of mechanical and electrical equipment should indicate definitely to the manufacturer that he desires complete protection and will expect it to conform with insurance, state and (if they exist) national standards.

It is, of course, useless to provide guards if they are not kept in position. While foremen should be held strictly to account for misplaced protection, the basic fault lies often in the design or construction of the guard itself. Sometimes the designer fails to take cognizance of some detail of essential operating procedure

with which the guard, when constructed, seriously interferes; sometimes the presence of the guard actually increases the danger in the performance of some detail of the operator's duties. In either event, the guard comes off and stays off as long as the operator is able to contrive it.

The most frequent cause of misplaced guards is the fact that protective efforts have been allowed to advance faster than the safety education of the operators and others who are to be protected. They have not been "sold" the value of the devices in question nor even asked to express an opinion on the hazards involved. If they have never heard of the occurrence of an accident from the source protected, it is quite natural that they should be unfavorably inclined toward devices which seem to them superfluous and at times in their way. Every man somewhat resents an effort to protect him from what he does not consider dangerous. On the other hand, it is surprising to find so few guards misplaced in a plant which is well organized for safety and where a true safety atmosphere exists.

Incomplete protection is a frequent cause of accidents and it is logical to suppose that, the more throughly we protect men from a common hazard to which they are exposed, the more dangerous it becomes to permit an exception to occur either at a given time or at a given place. In other words, we should protect consistently if we are to protect at all.

Many instances of failure to protect can be traced back to the opinion of someone in an executive or supervisory position that no one had ever been injured at such a place before or that no one would go to such a place while the machinery was in motion. The author hazards the opinion that *there is no place in proximity to machinery in motion to which men do not go at some time.* He recalls, for example, the opposition of a department head to certain recommended safety devices on the theory that the men were never exposed to the hazard while the machinery was in operation. On the basis of his years of experience on the plants in question he persisted in this opposition until confronted with convincing evidence gleaned from the accident files that men not only went to these places while the machinery was in motion but had been injured because no protection had been applied.

There is no moving machinery in existence that is free from accident hazard and no exposed moving part that is above

suspicion. It is the duty of the safety engineer or safety man, if not one of the duties of the operating supervisor or superintendent, to determine the extent of the hazard.

**Point of Operation Guarding.**—In most machines, exposure from the driving mechanism is occasional, while exposure to injury at the point of operation is frequent or may be practically continuous. This is particularly true of machines which are fed by hand, charged and discharged by hand, or must be adjusted, or have the stock adjusted, while work is in progress. The net hazard, moreover, is usually greater at the point of operation than at the power transmission or driving mechanism, not only because working conditions require the body or its members to be brought into closer proximity to the point of operation, but because the working parts, having been designed to cut or shear or crush efficiently, are capable of inflicting more severe injuries.

Notwithstanding the relative disparity between the two types of hazards, driving mechanisms are usually found better guarded than the points of operation of machines. This is due to the greater difficulty encountered in effectively protecting the operator at the point of operation without causing real, or fancied, interference with his work. Furthermore, when protection has been devised for this purpose it is apt to be only partially or intermittently effective, particularly on machines which are used for more than one operation or for work on various materials or on stock of different sizes. The general utility circular saw that is found in small woodworking shops is an excellent example of this, and no universal guard has yet been designed for it.

All of these elements contribute to produce a relatively high rate of loss from point of operation accidents. This is clearly indicated in Table X, which is based on the results of an analysis of 350,000 compensable industrial accidents by the National Bureau of Casualty and Surety Underwriters. It should be noted that the compensation costs of point of operation accidents in the lumber and wood industry were 42.6% of the total accident compensation cost, and in the machinery manufacturing industry were 90% of the machinery accident compensation costs. The lesson to be learned from this is obvious.

TABLE X.—COMPARISON OF MACHINE ACCIDENTS AND POINT OF OPERATION MACHINE ACCIDENTS ON BASIS OF COMPENSATION COSTS

| Industry | Machine accidents as % of total accidents | Point of operation machine accidents | |
|---|---|---|---|
| | | As % of total accidents | As % of machine accidents |
| Stone | 8.7 | 6.7 | 77 |
| Clay | 23.2 | 12.7 | 55 |
| Glass | 10.6 | 6.8 | 64 |
| Rolling and steel mills | 20.4 | 14.1 | 69 |
| Metal products | 38.8 | 29.4 | 75 |
| Machinery manufacture | 31.4 | 28.3 | 90 |
| Vehicle manufacture | 31.3 | 22.9 | 73 |
| Lumber and wood | 52.9 | 42.6 | 80 |
| Leather | 42.7 | 36.9 | 86 |
| Rubber and compounds | 47.0 | 35.6 | 76 |
| Chemical industries | 20.1 | 14.5 | 72 |
| Paper and paper products | 40.5 | 34.0 | 84 |
| Printing and publishing | 50.5 | 40.9 | 89 |
| Textiles | 43.7 | 29.9 | 68 |
| Clothing | 31.5 | 20.5 | 65 |
| Laundries | 47.2 | 33.6 | 71 |
| Food | 27.2 | 19.4 | 71 |
| Miscellaneous | 22.7 | 14.3 | 63 |

(Figures derived from an analysis of 350,000 compensable industrial accidents by the National Bureau of Casualty and Surety Underwriters.)

The prevalence of point of operation accidents is also shown in Table XII.

The final solution of the point of operation accident problem is probably to be sought in the realm of machine design and standardization of operations rather than in the application of safety devices. For continuous operations automatic feed and automatic stock removal not only minimize point of operation accidents but tend to increase production, while for non-continuous operations, automatic or semiautomatic machines are usually the safest in proportion to work performed.

For certain machines, protection for the point of operation has been worked out and, in some instances, standardized. Information should be sought from the sources mentioned earlier in this

chapter. Purchased machines do not, as a rule, come equipped with the point of operation protected. This is regrettable but will perhaps be corrected in the future as the general demand for complete protection increases.

**Personal Protection.**—With the possible exception of respirators to prevent the inhalation of dust, for which purposes several thicknesses of clean cheesecloth give, in most cases, reasonable protection and comfort, the common devices worn by the employe for personal protection are better purchased than fabricated. These include goggles for protection against flying particles, dust, injurious light rays, splashes of dangerous liquids or molten metal, and helmets, face masks, gas masks and other types of respirators, head protectors, gloves, aprons, leggings, special shoes, safety belts and life belts, and garments designed for special purposes.

It is only rarely that conditions are encountered which cannot be met by commercial protective devices already on the market, and in such cases the manufacturers or dealers are usually willing to undertake the development of what is considered necessary. In fact, the amount of service that the representatives of such firms are willing to render is little short of remarkable and has already done much to advance the work of industrial accident prevention. Certain it is that commercial personal protective devices have attained a high degree of excellence and only among new "freak devices" is one apt to find articles of dubious value. Of course, only such devices should be purchased as are guaranteed to meet existing standards, and insurance and state requirements.

There are numerous appliances not worn but for use by the employe, which are almost in the safety device class. These are usually implements or other portable appliances, or safety devices to be applied to common implements or portable appliances. Some, such as safety hopper car wrenches, are an actual necessity; others are of occasional advantage and many are of questionable value. When they are the outcome of safety suggestions made by plant employes, their adoption may be dictated by expediency, as an encouragement to the local safety movement, but it is always well to *scrutinize carefully the conditions that create the demand for a special safety appliance* with a view to changing the operation or otherwise obviating the hazard at its source.

The preceding statement, indeed, applies also to the adoption of any personal protective appliance. It is far better and more efficient, for example, in situations where it can be done, to remove dust by means of an exhaust system than to protect the eyes of the workers with goggles. Satisfactory shields, as barriers against flying particles, can be applied to lathes and grinding wheels. To take another case: It is better to provide a railed walkway over a coal hopper from which "bridges" may be pried loose with bars, than permit employes to enter the hopper even when protected by life belts.

The major difficulty encountered with personal protective devices is not in their provision nor in their protective efficiency, but rather in their effective use. The question, "Where can I obtain a good chipper's goggle?" is rare in comparison with that of "How can I get my men to wear goggles?" The answer to the latter question is that the introduction of the safety spirit into the plant, when accomplished, will impel the use of all reasonable safety appliances, personal or otherwise. The foremen *can* make their men use these devices and use them properly, but the foremen themselves must first be "sold" on safety, and the management above the foremen. The author has visited foundries where each man had his goggles and wore them or not as he saw fit—and other foundries, such as that of the Commonwealth Steel Co., where the manager himself not only wore his goggles, but saw that every visitor was equally well protected.

If personal protective devices are not generally worn when they ought to be, it is usually because the manager or superintendent has not taken sufficient interest to insist that they shall be worn. Aside from this, it may be because they are not:

1. Suitable for the purpose.
2. Properly fitted to the individual.
3. Provided free of charge.
4. Readily obtainable.
5. Kept in condition by the management.

The necessity for maintaining personal protective devices in first-class condition is obvious and all such appliances should be inspected at regular intervals. Devices for emergency rather than constant use on which an employe's life may depend, such as life lines and belts, gas masks and helmets, should not only be given a periodic inspection but ought to be examined carefully each time after being used. If a device is intended to save life or

prevent injury, failure to keep it in safe and effective condition is inexcusable.

**Eye Protection.**—Let us consider for a moment the eye protection problem. The National Safety Council has estimated that every year there are about 250,000 industrial accidents causing injury to the eye. The National Committee for the Prevention of Blindness tells us that there are in the United States 15,000 persons who have lost their eyesight through industrial accidents.[1] This organization by means of questionnaires sent to selected industrial properties developed the following data from their experience during the year 1922:

| | |
|---|---|
| Number of plants reporting | 72 |
| Approximate total employes | 168,000 |
| Total number of goggles in use | 18,205 |
| Total eye injuries | 15,989 |
| Serious eye injuries known to have been prevented by goggles | 1,522 |

In round figures, then, in each group of 10 men one had his eyes injured to some extent. Of each 10 pairs of goggles one pair saved the loss of an eye and yet only one man out of every 10 appears to have been provided with such protection. Admitting that there are very many occupations which do not involve an eye hazard, the provision of goggles on these plants certainly seems inadequate. Did the employers fail to realize that an expenditure of $20 for goggles for 10 men and some effort to have them worn would save about $1,500 in compensation expense?

One plant of a prominent corporation spent in 2 years $7,000 for goggles for its 1,400 employes, 800 pairs being ground to prescription. In 1 year alone, 54 pairs were completely smashed, 23 pairs were smeared entirely with molten metal, and 111 lenses were cracked by flying fragments. On a conservative estimate, the plant saved $50,000 in one year on an investment of $3,500!

By the use of goggles one corporation reduced its eye accidents 75%, and one plant of another corporation, which had 125 lost-time eye accidents in 1923, had only one case in 1924!

The condition of goggles should be determined by regular inspections made by the foremen. Something more, however,

[1] Resnick and Carris, "Eye Hazards in Industrial Occupations," National Committee for the Prevention of Blindness, Inc., p. 3, New York, 1924.

is needed—goggles must be suitable for the purpose and, where there is defective vision, should be ground to prescription.

The Eyesight Conservation Council of America is authority for the following statement:

> Industry has an important discovery to make, namely, that in addition to serving as a protector there should be embodied in the goggle provision for the correction of defective vision. Herein lies the answer to much of the objection to wearing goggles—the true reason for which is recognized neither by the safety man nor the workman. A majority of workmen have defects of vision of more or less severe degree. With defect of vision existing, unrecognized by the workman but handicapping him to some degree, the goggle apparently serves to emphasize the defect. As a result the workman blames the goggle . . . Experience has demonstrated that where defective vision exists, objections to wearing goggles are overcome when the goggles are fitted with lenses which correct the eyes.[1]

**Warning Signs.**—Of least value in actual protection are warning signs, and little or no dependence can be placed on them as a preventive medium. There are innumerable cases on record where men have been killed or injured by performing the very act forbidden by a sign in plain sight from the point of disaster. The author recalls the death of an experienced millwright on a revolving shaft which he was oiling, in violation of a sign reading "Stop Machinery before Oiling" located on the wall immediately below the bearing he was endeavoring to reach. This is but one instance of what has been common industrial experience.

Signs bearing more general injunctions, such as "Be Careful," "Safety First," "Avoid Danger" and "Take No Chances" have even less value and probably serve no good purpose other than advertising in a general way the existence of some mild degree of interest in the safety movement. What is said in signs can often be said to much better purpose in safety rules. Plastering a plant with vague and pointless signs is an unintelligent expenditure of effort.

Warning signs, nevertheless, do serve certain useful purposes. They are used as indicators of hazards not immediately obvious to persons unfamiliar with their surroundings and their use as such is justified either as a temporary expedient or where the hazard cannot be removed or obviated. For example, signs to

[1] *Bull.* 7, "Eyesight Conservation Survey," The Eyesight Conservation Council of America, p. 114, New York, 1925.

denote railroad crossings and close clearance to tracks are necessary, blue flags or targets to indicate that railroad cars are being worked upon are justified, and markers on pole or stack guys are desirable. There are situations where the use of signs reading "Danger—Men Working Overhead" is an added safeguard, though it is far better either to prevent men from exposing themselves below by stationing guards, roping off an enclosure, or closing the entrances, or to protect them with nettings or temporary ceilings if it is absolutely necessary for them to work in an exposed position.

Another and rather frequent use of warning signs is on clutches, valves, electric switches and other starting or control devices when men are working on apparatus or equipment controlled by them. Here again their use is not a positive safeguard except perhaps in isolated instances where the controls are under the constant supervision of an experienced man, such as a power station switchboard operator, in which case the sign functions merely to prevent his performing an absent-minded act. It is far better practice to lock the switch, clutch lever or valve in open position so that it cannot be operated under any circumstances, and if there is still a possibility of the power being applied in some manner, to counteract it in the most appropriate way.

The latter precaution may take the form of disconnecting and grounding the electric lines that are being worked upon or, in small installations, removing feeder circuit or transformer fuses. In the case of mechanical power, belts may be removed or pulleys effectively blocked. When men are working in tanks or boilers, all pipes through which dangerous liquids or gases might enter should be entirely disconnected, blanked off and the pressure relieved on the supply side, or the line may be safeguarded by two closed (and locked) valves with an open bleeder between. Even the last arrangement may fail to protect if the bleeder is carelessly closed or becomes plugged. Such a valve should not be less than a $\frac{3}{4}$-inch gate valve, it should have an open discharge and it should be blown clear before the main valves are closed and locked. Failure to do this recently caused the death of an employe working in the steam drum of a boiler in a large power house which for 4 years had not had a lost-time accident.

Another legitimate use of signs or markers is to prevent mistakes in similar equipment. For example, boilers in battery should be numbered in front, at the blow-off valves, on top close

to the non-return valves and also at the stop valves along the main header. Where electric motors or other sources of mechanical power are remote-controlled, the starting mechanism should be numbered or otherwise designated to prevent possible mistakes.

It is also important to properly designate piping systems and especially their control valves. For information on this the reader is referred to the American Engineering Standards Committee, which at the time of writing had practically completed its code on "Standard Designation of Piping Systems."

## CHAPTER XIX

## RELATED ACTIVITIES

There are many branches of industrial welfare or "service" work which, when properly carried on, do much to make easier the introduction of the safety idea and facilitate the attainment of a substantial no-accident record. Many of these activities are corollary to safety work and some are indispensable to its full and effective development.

**General Working Conditions, Physical and Mental.**—It is almost a wasted effort to undertake to reduce accidents in a dirty, disorderly or otherwise uncomfortable shop or in a plant which is run loosely and without order or discipline. In such places labor turnover is usually high and the workers are indifferent to the desires of the management.

These conditions may result from, or be augmented by, a wage scale that is below that prevailing in the neighborhood, but they are oftener due to the indifference or lack of knowledge of the management itself. If an industrial manager desires a clean and orderly establishment he can secure it, regardless of the nature of its operations. There is no industrial process that cannot be made reasonably clean and orderly.

In obtaining a clean and orderly establishment a great deal depends on the existence of "plant spirit" or, the possibility of creating it. Such a spirit, which is equally necessary for successful safety work, cannot exist when loyalty is absent. Loyalty itself is inhibited by disrespect, and disrespect is in turn engendered by either physical or mental dissatisfaction. The employe may be dissatisfied with his surroundings or conditions of work or may, as is often the case, harbor resentment because of treatment which he considers unjust. He expects, above all, justice—fair treatment:

> Given and assured of industrial justice—if you will accept that term—there is nothing more needed to produce industrial harmony in its highest sense. And, mark you, my friends, there is nothing less or nothing else that will do just as well. There is no substitute for justice.

You cannot put wages enough into a pay envelope to make a happy, contented and successful worker out of a man who feels that he is being imposed upon, that he is being denied his rights, that somebody else is getting more pay for less work or less valuable work, or is getting privileges and opportunities of any kind that are denied to him.[1]

To correct faulty conditions the house must first be put in order and labor, as far as possible, stabilized. It matters less that the latter is brown or white, foreign or native than that it is reasonably paid, well taken care of and treated with consideration. Negroes and foreigners can become as interested and persevering in maintaining good working conditions and in accident prevention as native-born whites.

Reasonable places in which to work, reasonable facilities for doing work, reasonable wages and reasonable treatment as individuals and as a body are essential. There should be proper lighting, heating, ventilation, drinking water, lockers, washrooms and toilets. In larger plants, a clean lunchroom or cafeteria where good food may be obtained at moderate cost should be provided. A recreation hall or "club" where the men may congregate during the noon-hour to smoke, talk and indulge in games is very helpful.

If the plant is so fortunate as to have its own village and be largely independent of city residence conditions, the work will be made easier since the community becomes a unit and, if properly encouraged, tends to develop a spirit. In any event, the management should work faithfully to continually better the living conditions of its employes in the matter of dwellings, transportation facilities to and from work, schools and other normal requirements. The development of facilities for family recreation, the organization of plant teams and the promotion of community enterprise are worth while and pay dividends in loyalty and decreased labor turnover. A plant periodical promotes plant spirit, knits together the community and serves as a publicity medium for reaching the employe and his family on live subjects, of which safety is one.

All such activities are practical welfare work of a type much more appreciated by the worker and less apt to be considered paternalistic than the so-called "plans" which make demands

[1] YOUNG, ARTHUR H., "The Obligations of Employer and Workers in Successful Production," Address at the Twelfth Annual Meeting of the Chamber of Commerce of the United States, May 6, 1924.

upon him as an individual and especially upon his pocketbook. While there is much to be said in favor of profit-sharing, bonus, stock subscription, savings, sickness, death benefit, pension and other welfare plans, their actual effect on turnover and on plant loyalty is difficult to determine. Plans which are non-discriminatory, non-contractural and impose no individual financial obligation, such as vacation plans and group life insurance, probably have a direct, positive value. Employes' representation in its various forms presumably stabilizes labor conditions and tends to promote loyalty even though it may have no direct value as a medium for promoting interest in accident prevention. We cannot generalize, however, without danger of gross error, and the value of a plan depends not so much upon its purpose as on its intrinsic soundness and appeal.

**Physical Examination for Employment.**—In some states periodic physical examination of workers engaged in certain occupations is required by law or by regulation of the Department of Labor. Physical examination for life insurance we are all acquainted with. Nevertheless, physical examination on application for employment is not regarded with favor by organized labor and, though of unquestionable value to the individual himself, is frequently objected to. It is, indeed, employed too often in a negative way, that is, as basis for rejection, and too seldom in a positive way—as basis for correction.

As protection against unjust claims for compensation, particularly those based on alleged diseases of occupation, as an aid to intelligent placement or transfer and as protection to the man himself, especially when exposed to working conditions that are unavoidably exacting or hazardous, or to his fellow employes with whom he may be engaged in extra-hazardous occupations, physical examinations are of the highest value. Proper physical examinations and the proper application of their results require knowledge, experience and no little technique. Unfortunately, this is not always forthcoming.

In general, however, employers are not getting the full worth of their money from these examinations. This primary purpose is not being served as well as it might be. The deficiency is not that the medical men engaged for industrial work are poorly equipped, but that they have not specified, and made tests for, the appropriate physical requirements of mechanical jobs. Until the Workmen's Compensation Acts secured them assignments in factories, their experience with physical

tests, on a scale large enough to develop a technique, have been gained in just two fields—insurance and the army. The types of examination which grew up in these fields had, in each case, a special purpose in view; the insurance routine was designed to exclude applicants found suffering from functional diseases, and the military examination aimed to sift out rookies who would prove unfit for campaigning.

The industrial examination is an outgrowth of those two procedures. They had, in neither case, pointed to the disclosure of any special accident liability; therefore, the industrial routine has failed to do so. An exception, of course, might be cited in the case of railroad workers, examined for color sense, for ability to hear a watch tick and, perhaps, for other minor faculties. But even the railroad examinations had in view only the selection of men who could comprehend signals well enough to avoid wrecking trains. There was no effective idea of preserving employes from injuring themselves.

With the routine of the insurance doctor before them, therefore, and such forms as they could get from the Surgeon General of the army, and from company physicians in the railroad claim departments, the early industrial physicians sat down and devised an examination blank. Their inspired product of a decade ago is used, with sterile uniformity, in most factories today. They have advanced little since, and, so far as they have gone, it has been chiefly in the direction of medical diagnosis, rather than in the direction of appraising the workmen's native equipment. From time to time they have added Wassermann tests, laboratory tests for hookworm (in southern mills), medical history, and other items. The recent experience of many of the doctors in the army has spruced up the examination form a bit; it has caused some to add a few more items, such as, "endocrine system." The terminology is a little more standard.

Little by little, too, the experienced workers in the plant hospitals have learned from the accident records what are some of the most definite compensation hazards. This, however, is not precisely the same thing as discovering the predisposing *accident* hazards. For instance, a man blind in one eye is a special compensation risk, because, if he should happen to lose the other eye, the company would have to pay for total blindness. A man with one eye defective, however, is also an accident hazard. If he lacks stereoscopic vision, he cannot accurately judge distances. If he is near-sighted or otherwise deficient in focus, he may stumble into an accident. Clearly it is just as important to consider this type of impairment as gross injuries. But they are not so patent. It is easy to know the direct compensation risks; they show up on the records. It requires much more study, and, oftentimes, a knowledge of particular jobs, to appreciate the more subtle accident hazards. Hernias, bad hearts, positive tuberculosis indications, missing organs and members, and epilepsy (where it can be detected) are evident risks.

And the physician has not been urged to inquire beyond such possible trouble and look for more obscure ailments.[1]

The physical examination of new applicants should be made primarily for the purpose of establishing a dependable record of condition when employed, to permit intelligent placement and for the purpose of giving friendly medical advice or treatment that will enable the man to become a better physical specimen and of greater value to himself and to his employer.

As a means of weeding out the obviously unfit, those mentally or physically incompetent for ordinary labor, the epileptics, the drug or drink addicts, men afflicted with serious contagious diseases who would be a menace to their fellow employes, and others who belong properly in hospitals or other institutions, the physical examination is of secondary importance. Such cases, though numerous enough, are small in number compared with those who are slightly abnormal mentally or subnormal physically through deformities, impaired health, defective vision, hernia or tendency to hernia, deafness, lead poisoning, heart weakness, varicose veins, chronic rheumatism, latent syphilis and numerous other all too common ailments. Entire rejection on account of such defects is a practical impossibility, particularly during periods of labor shortage, but if the condition is known and recorded the employer is not only able to effect more intelligent placement but is to some extent protected against future claims. Such claims may be directly fraudulent but are more often merely the result of ignorance on the claimant's part, especially when a physical injury has actually occurred and has aggravated, or been aggravated by, a prior physical or mental condition. In this way alone the employer will be repaid for the cost of physical examinations.

The greatest benefit will undoubtedly come in the placement of new men, assuming that the results of the physical examinations are intelligently applied. Unquestionably many accidental injuries are the indirect result of placing men at work for which they are not adapted. This is apt to be the case on large plants (and on all plants when labor is scarce) and is traceable sometimes to lax operating supervision, sometimes to unintelligent employment methods and sometimes to lack of understanding or coopera-

[1] FISHER, BOYD, "Mental Causes of Accidents," p. 56, Houghton Mifflin Company, 1922.

tion between the employment office and the department which requisitions the men.

**Periodic Physical Examinations.**—These are highly desirable for employes who have recognized physical defects of a sort that in time may be expected to become worse rather than better, or latent diseases which at any time may become unexpectedly active. Employes with predisposition to hernia, inactive syphilis cases and men who have formerly been tubercular are examples. There are other cases that should be examined before being transferred to other employment, and many companies insist that all transfers shall be viséd by the plant physician.

There are also occupations which justify a periodic physical examination. Men exposed to acid or other dangerous or deleterious fumes or gases, to dusts, excessive heat, pressure, steam, or poisonous material should be given periodic examinations under some conditions as often as once a month. Periodic eye examinations are advisable where employes are subjected to severe eyestrain, as happens in a number of trades, since defective vision is in itself a constant cause of accidents and spoiled work, to say nothing of its effect on general health. Dental clinics have their value.

Another and often neglected opportunity for effective work through periodic physical examination and placement is among employes above the age of 55. Men of this age are usually reluctant to admit their increasing unfitness for the employment to which years of service has accustomed them, and accidents come upon them most unexpectedly from hazards with which they have been long familiar. Among woodworkers and machinists it is not unusual to find men who, though formerly safe operators of machine tools, have reached an age where they are physically handicapped and are no longer safe men.

One frequently encounters night watchmen who are old employes considered unfit for regular work, sometimes crippled and often with defective vision; yet these men are expected to make rounds at night in poorly lighted buildings, climb steep stairways and sometimes ladders, and in an emergency, such as a fire, perform service that would tax a younger and more agile man. While it is true that the accident records of some industrial plants do not show an unusually high frequency rate for employes of advanced age, it can be explained by the fact that the limitations of many such men have been previously recog-

nized and they have already been given jobs in which there is little likelihood of injury. Their injury severity rate, however, is high partly because they are prone to accidents from falling, which involve serious back, leg or foot injuries, and partly because recovery from a major injury of any kind is slower than with younger men and permanent impairment is more apt to result.

All physical examinations should be carefully made by an experienced physician who should be fully cognizant of the employment, the actual conditions under which the man works, or will work, and the probable demands that will be made on him by his occupation. This necessitates the making of occasional trips through the plant by the physician.

The commonest fault with the examination itself is that it is often hurried and sometimes inexcusably superficial, but for this the employer is usually to blame. Another defect is that the record of the examination is incomplete, non-informative or illegible, a defect that may often be corrected by providing a hospital clerk or a capable nurse or orderly. A third and very common fault is that the results of the examinations are not taken into consideration in connection with the placement of the men, and under these circumstances it is natural that the physician should lose interest and that the employer should lose the principal benefit of the work. At some plants employes are never told what the physician discovers and an excellent opportunity to create interest and loyalty has been lost.

In the case of new men, physical examinations should be made prior to, and not after, employment. Only in plants too small to warrant retaining a physician to visit the plant regularly at certain hours, or make the requisite examinations at certain hours in his own office, is there justification for delaying examinations several days after employment. It should be remembered that many men are injured on the first day of work.

**Mental and Psychological Examinations.**—This is a subject of increasing prominence though still largely in the experimental stage, especially in industry, to which its application is comparatively recent. Mental and psychological tests have been applied for some time in government service, in particular in the army, and much work has been done along this line in the schools. To what extent they may prove of value in selecting industrial workers is yet to be learned. It seems probable that their princi-

pal value will lie in selection for special jobs, for which a high degree of intelligence, skill, care or other qualification is demanded or over which normal supervision cannot be maintained.

As with physical examination, mental and pyschological examination is a matter of individual rather than mass selection. Its purpose is corrective and directional, for it aims to select the available man who is best adapted to a particular job and this means that the requirements of the job itself must be accurately known.

It is interesting to note that one semi-industrial field in which material progress has been made was entered primarily for the purpose of controlling accident occurrence. It also presented a complicated situation in which the employes were thrown on their own responsibility and were largely beyond the range of immediate supervision. This field is that of taxicab operation, in which valuable and interesting work is being done by A. J. Snow, of Northwestern University, for the Yellow Cab Company of Chicago. Data recently published[1] indicate that a group of drivers who had been selected by means of mental and psychological tests showed the following accident record in a 2-month period as against the remainder of the drivers who had not been selected by such tests:

| | Accidents per man | | |
|---|---|---|---|
| | Involving personal injury | Involving property damage | Total |
| Tested drivers | 0 10 | 0 44 | 0 54 |
| All other drivers | 0 18 | 0 61 | 0.79 |

Comparing the first 4 months of 1925 (during which new men were selected by means of these tests), and the same period in 1924 (when no such selection was made) with 1923, it was found that, whereas the total miles operated by cabs had increased 38 and 34%, respectively, the number of accidents had decreased 0.3% in 1925 as against a 29% increase in 1924. Snow also found it possible by means of these tests to predict labor turnover with a fair degree of certainty.

If the selection and placement of industrial workers can be facilitated by the application of mental and psychological exami-

[1] SNOW, A. J., "Tests for Chauffeurs," *Industrial Psychology*, **1**, 1, p. 30.

nations or tests, it will unquestionably have a beneficial effect on labor turnover, production efficiency and accident prevention itself. The safety engineer, therefore, is urged to keep in touch with developments in this obviously important field of applied science.

**Medical and Surgical Service.**—In the case of injuries, such service is of course obligatory in some form and to some extent in accordance with the requirements of compensation laws. It also provides a direct and easy path to the sympathies of the employe at a time when he is very susceptible to advice (provided always that the service rendered him is acceptably and creditably performed) and is, besides, an indispensable corollary to the safety work. Wherever possible, the services of an industrial physician should be engaged and preferably one who is experienced, skilful, sympathetic and capable of becoming interested in plant working conditions. If he possesses, in addition, executive ability, he is exceptional and is worth a liberal salary, especially in view of the comparative scarcity of experienced industrial physicians.

The presence of the right man—and particularly one who does not confine himself within the four walls of his office—will do much to reduce injury frequency, severity and lost time on account of sickness. There will be fewer infection cases on his plant, fewer deformities, fewer cripples and probably fewer deaths. On the other hand, there is no excuse, moral or economic, for indifferent medical service. Such a deficiency will be detected at once by the employes, and if the doctor or plant hospital has acquired a bad name among them, rigorous changes will have to be made before it can be reinstated in their good opinion.

Proper housing and facilities for first aid, medical and surgical work are obviously necessary, and such assistants as are required to meet the needs of the local situation. In plants employing less than 1,000 men, a plant hospital and the services of a full-time industrial physician are usually difficult to justify unless the process is an extra-hazardous one. The actual cost, however, is somewhat lower than might be supposed. A comparison of medical costs in plants of the duPont Company in 1922 and 1923 indicated that they were 24% of the total non-fatal injury costs in plants having hospitals, as against 29% in plants using the services of outside physicians. These figures excluded interest and depreciation on the plant hospital buildings.

Plants with 200 to 1,000 employes can usually afford to retain the service of a capable man who will maintain daily office hours at the plant and give its employes his best attention. An experienced first-aid man or nurse usually acts as his assistant and is at other times available for emergencies. Plants smaller than these rely chiefly on first aid and upon the services of doctors who are within call. There are, besides, in most large cities, physicians who make a specialty of industrial work but see their patients at their office or at one of the local hospitals. Such physicians cannot, of course, do as much toward improving plant accident or health conditions as a resident physician or one keeping regular office hours at the plant.

**First Aid.**—Proper first-aid treatment of injuries is by far the most important adjunct that accident prevention has. It is the first line of defense against extended disability from work, permanent disability from amputation or loss of function and possible death. The germs of infection may reside in any wound. In the case of hand injuries, 15 to 20% of the disability and 50% of the deformities are said to be caused by infections, although 65% of the injuries are of minor nature.[1]

The incidence of infection in industrial injuries varies between wide limits. A plant in Wisconsin which relied on the services of a "male nurse" reported infections in 17% of its compensation cases. One medical authority reports 7.6% of his cases infected, while another's experience shows only one-eighth of 1% in 77,554 cases.[2] But first aid is more than the prophylaxis of infection; it covers the entire field of proper treatment in the moments before the arrival of the qualified expert—treatment which may prevent prolonged or permanent disability and moments in which life itself may be saved.

The essential provisions for first-aid work in an industrial plant are the following:

1. Strict enforcement by foremen of the rule that every injury must be reported at once for treatment.
2. Provision of first-aid dressing stations at points reasonably convenient.
3. First aid administered only by those who have been carefully trained and are experienced in the work.

[1] SHERMAN, WILLIAM O'NEIL, "Saving Fingers through the Prevention of Infection," *National Safety News*, p. 15, May, 1922.

[2] *Ibid.*

4. Full and complete record of every treatment.
5. Reference of treatment record to the plant physician.
6. Follow-up to determine progress of the case, including visit to patient's home if absent from work.
7. General instruction of foremen and supervisors in first-aid principles and emergency first-aid methods such as artificial resuscitation and checking hemorrhage.
8. Constant publicity on dangers of infection and necessity for immediate reporting of *all* injuries.
9. Organization of first-aid teams if size of plant permits.

The mere provision of numerous first-aid cabinets together with an occasional injunction, oral or printed, to "report all injuries, no matter how small" is by no means enough, nor can satisfactory first aid be performed by referring to a book. Experience and constant practice in first aid are necessary before the treatment can be relied upon and, in an emergency, it is better to have available one expert employe who has been doing all the first-aid work from day to day than a score of flustered amateurs who have forgotten half of what they have read or listened to.

So also with the equipment—scattered first-aid "kits" make for depleted supplies (the materials needed in an emergency are always those that happen to be missing!), and for amateurish treatment, self-treatment by the unskilled and unreported treatments. It seems to the author far better to provide one or more reasonably equipped and properly maintained first-aid rooms (each one of which can be installed at less than the cost of a serious infection case) than a multitude of "kits" located in as many separate departments.

It is hoped that these remarks will not be construed as an attempt to disparage the value of first-aid instruction! First-aid classes should be established wherever it is practicable to do so and should lead up to the formation of first-aid teams. Some of the largest industrial and public service corporations make such training a prerequisite to service on safety committees. A knowledge of first aid is an admitted stimulus to accident prevention. It has served on innumerable occasions to save life outside the industrial environment, sometimes in the employe's own home. It teaches, above all, respect for the work of the trained physician and surgeon, so that the student recognizes what the layman does not—the boundary between first aid and the province of the expert.

Artificial resuscitation and the manner of checking hemorrhage should be taught to as many employes as possible, even in a small plant, but this instruction should include actual practice in performance under the guidance of an expert. Such practice should be repeated at least once a year—preferably oftener.

**Returning the Injured to Work.**—While hardly a branch of welfare work, this is a subject worthy of special mention. In many industrial plants little attention is given it with the result that employes who have received a very trivial injury and could return to work on the following day are allowed to lay off and others, somewhat more seriously injured, are not returned as soon as able to undertake light or special work. This is particularly true where accident cases are customarily treated by an outside physician, or where the plant physician does not interest himself in the plant safety record; not that the physician in either case deliberately prolongs the period of disability, but rather that he does not give the matter serious thought, probably believing that if the patient is at home he is more likely to take care of his injury and less likely to exert himself unduly.

An employe is often willing to lie around the house a day or two on the doctor's orders nursing a comparatively minor injury that gives him little pain or inconvenience or, when recovering from an injury entailing longer disability, after being petted and pampered by his family, is apathetic or disinclined to resume work so long as he is paid compensation. These are forms of petty malingering which affect, in the one case, the frequency rate and, in the other, the severity rate. They are, indeed, the forms in which malingering is most frequently encountered.

The author believes that the physician should assiduously endeavor to procure there turn on the following working day of employes who have been only slightly injured and the more serious cases as soon as they are able to perform light work of any nature, provided, of course, he feels that they run no real risk by so doing. To effect this the doctor must first be interested in the plant's safety work in order that his intelligent cooperation may be secured; also the management must do its part by finding light work of the sort prescribed by the doctor.

It should, of course, be understood that the maintenance of a good safety record is not the true purpose of returning injured men to work as soon as possible; it is intended primarily to discourage both conscious and unconscious malingering. Further-

more, it is generally conceded that injured men, after a certain stage has been reached, recover more rapidly when at work or reasonably active than when lying in bed or propped up on cushions in the living room. It is also common experience that the longer invalidism is allowed to continue the more difficult becomes the conscious effort necessary for return to the normal.

Actual experience with returning injured men to work on plants of the duPont Company has been most successful in spite of the early apathy of some of the physicians who felt that it might jeopardize the recovery of their patients, and the opposition at first aroused in operating officials who saw in it an unjustified effort to secure a good injury record or felt certain that sufficient light-work jobs could not be found in small and well-systematized plants. As a matter of fact, their misgivings were not supported by experience; the procedure has proved to be economically sound, has reduced accident costs as well as rates, and in no instance has as yet been followed by bad physical after-effects. It has appeared to have the moral support of the employes as a body and, in a number of instances, especially when the plant no-accident record has been at stake, they have themselves aided in inducing prompt return of the injured.

In particularly refractory cases, the threat of refusing extra compensation benefits or discontinuing compensation payments for temporary disability is sometimes employed, though usually the orders of the attending physician furnish sufficient incentive. It is one of the duties of the plant safety engineer to follow up all disability cases. Check-up visits to the patients' homes may be necessary and for this the services of a visiting nurse prove useful.

**Employes, Benefit Association.**—Such organizations function primarily to furnish monetary relief in event of disability or death from any cause. They are capable, however, of influencing the plant accident situation in several ways, such as:

1. Through physical examination of applicants and provision of health service.

2. By checking up absence from work on account of claimed disability from industrial accidents and thus discouraging malingering.

3. As a mutual organization, by promoting *esprit de corps.*

As regards their effect on plant spirit the National Industrial Conference Board observes:

While it is difficult to establish any direct connection between the mutual benefit association and production efficiency or labor turnover, it is highly significant that not a few employers are of the firm belief that the effect of benefit associations upon these factors is, nevertheless, considerable, though intangible and not to be measured in dollars and cents. Employers believe that the interest manifested by management in the association, expressed either through direct contributions to it or through the provision of facilities to enable it to conduct its business on an efficient basis, is of inestimable value in building up confidence and good-will in the plant. Through the sympathetic contacts established with members who are drawing benefits, and the "family spirit" which is fostered by an association's social activities, at which management and employes meet on an equal footing as members of one group with a common object, an *esprit de corps* is created among employes that is of permanent and lasting value.[1]

**Malingering.**—Some further discussion of this subject may not be inopportune. Malingering is usually encountered toward the end of the period of temporary disability or when settlement for permanent disability is being attempted. In default of evidence to the contrary, it seems to be good policy to give the claimant in contested cases at least the benefit of the doubt. The bugbear of malingering is, in the author's opinion, more imaginary than real, and the number of intentionally dishonest individuals in the industrial world who seek compensation or other benefits under false pretenses is probably not large, although extreme cases may be found in the history of every large plant.

It has been observed that the true malingering is sporadic and apt to occur with greater frequency in plants which pursue an illiberal and unsympathetic compensation policy (and are therefore peopled by a relatively poorer grade of employes) than in plants in which both management and employes are relatively high grade and are accustomed to cooperate. It is also in the neighborhood of the former class of plants and among dissatisfied employes that the unscrupulous doctor and the "shyster lawyer" find their clients.

Unconscious malingerers, on the other hand, are not representative of a class but rather of a temperament or mental condition which may occur in any classes. They may or may not be

[1] "Experience with Mutual Benefit Associations in the United States," *Research Report* 65, National Industrial Conference Board, p. 13, 1923.

otherwise desirable employes and probably but few, if any, can be detected and weeded out at the time of employment. Their malingering propensities are developed by the occurrence of an accident or sickness, usually followed by slow recovery, and though additional compensation benefits may effect a final cure, it is questionable whether the existence of a liberal compensation policy has any effect for or against the occurrence of these cases. Each has its individual characteristics and must be treated on its merits and in accordance with its symptoms. Some cases may be terminated by discontinuing compensation, others by giving additional medical or surgical treatment, and still others by granting additional benefits.

**Compensation.**—No employer who is sincere in his efforts to prevent accidents will permit unfairness in the treatment of injured employes. He will satisfy himself that compensation in accordance with the law is paid promptly to the injured or the dependents of the deceased, whether he is self-insured or covered by an insurance company or in a state insurance fund. If he carries outside insurance he surrenders his financial, but not his moral, obligation to see that justice is done and that humane, courteous and sympathetic treatment is accorded those who have suffered a loss. At such times there is presented to him one of his greatest opportunities to strengthen relations with his employes and confirm their belief that he is sincere in his expressions of interest in their welfare.

In compensating injured employes, some employers, including many large corporations, prefer to exceed the letter of the law, not only in especially needy or otherwise deserving cases, but in pursuit of a general policy. Sometimes the waiting period is reduced below the statutory or is even abolished and compensation paid from the time of injury. Sometimes the rate of compensation payment is the full-wage rate instead of the percentage prescribed by the statute, maintained either for the full period of temporary disability or retroactive for the full period, if temporary disability extends beyond a stated limit.

Without respect to statutory provisions many employers regularly furnish unlimited medical and surgical treatment and surgical appliances, such as trusses and artificial limbs, and renew them when worn out, provided the injured remains in their employ. Another form of voluntary compensation, which is most commendable, is the extension of compensation payments

beyond the period stipulated by the law to those who have been permanently and totally disabled or to the immediate dependents of the deceased, until they are able to adjust themselves to changed conditions of life.

The legal obligation of the employer is well defined by the compensation statutes and the rulings of the compensation boards or referees to whom contested claims are referred. How far the employer should go in exceeding the legal requirements is largely a matter of inclination and judgment. This is no place for discussion of the subject and it will suffice to point out that, while there are strong reasons for opposing the present tendency toward liberalizing existing compensation statutes, there are equally strong reasons for employers voluntarily adopting a liberal, though discretionary policy in the compensation and relief of their injured employes. That it serves to strengthen industrial relations and accelerate accident prevention cannot be doubted and many employers will testify that it returns dividends in loyalty and good-will.

**Rehabilitation.**—There is often much that can be done, surgically, educationally and in the way of placement, for those who have been physically handicapped by the results of an accidental injury. Corrective operations are sometimes possible and special treatment such as massage, baking and functional reeducation are often prescribed.

When the final degree of permanent disability has been determined, the question of reemployment arises. Every effort should be made to reestablish the injured man in a position in which he may earn at least as much as he was earning before and which carries with it some possibility of future advancement. In some cases this may require training in a new trade or employment, possibly in an institution devoted to industrial rehabilitation.

The most hopeless cases may never, of course, become again desirable employes or entirely self-supporting, but the employer can at least take consolation in the thought that he has done his best to prevent their lives from being utterly wasted and has probably added some happiness to their existence. As for those who are only partially crippled, it may be said that in the past industry has erred in making many of them gatekeepers, watchmen and "pick-up men," when with a little expenditure of thought, patience and money, it might have returned them to

more useful and happier employment. Even many of those pronounced totally disabled and unfit for any gainful occupation, if the work is undertaken soon enough and with foresight and patience, can be rehabilitated to some degree of occupation, if not to actual earning power.

**Fire Prevention.**—The National Fire Protection Association is authority for the statement that some 15,000 persons lose their lives annually from fire and burning.[1] Most of these accidental deaths do not occur in conflagrations but from small fires and from burns received from hot objects and liquids. Although there appears to have been some tendency in the past to regard fire prevention and accident prevention as separate fields of endeavor, evidenced by the existence in this country of a National Fire Protection Association and a National Safety Council,[2] fire prevention or protection and accident prevention or safety cannot be effectively dissociated. Consequently, the safety engineer and safety committees should function also in this field of fire prevention. For the same reason, no industrial establishment can afford to neglect its fire prevention work if it intends to undertake intensified safety work. This is too obvious to merit further discussion.

**Safety Outside the Plant.**—Safety is not a mental garment which a man may put on with his overalls and divest himself of when he leaves his work, and the careful man is careful, in the better sense of the word, at home as well as in the shop. Furthermore, safety inculcated through his home will accentuate what he learns during his employment. To this end his wife and children may be utilized to support the efforts of his foreman and safety committee.

Safety should be taught in the elementary schools, not only for its indirect effect on the worker through the medium of his children, but in order to decrease the appalling number of child accidents and develop in those who are to be the workers of the future the right mental attitude toward accidents and unjustifiable risk. Every large employer, therefore, should do what he can to bring about the teaching of safety by accepted methods in the public and parochial schools of his neighborhood. Information

[1] There is some question as to the accuracy of this estimate. Compare rates shown in Fig. 1.

[2] These two national organizations are cooperating closely to mutual advantage.

on methods which have been endorsed by the leading educational authorities of the country, can be obtained from the Education Division of the National Safety Council, which, through the financial support of the National Bureau of Casualty and Surety Underwriters, has published a manual for the use of teachers, a school periodical and other subject matter. In cooperation with the National Society for the Study of Education, it has also produced a year book of approximately four hundred pages on "The Present Status of Safety Education."

Many school authorities have already introduced the teaching of safety in the schools and many more would do so if shown the propriety and value of it and if furnished with concrete methods and materials. It is to be regretted that so many industrial managers, even though actively engaged in promoting accident prevention in their plants, have not as yet become sufficiently interested to ascertain whether their own children are properly educated in the subject, much less the children of their employes, many of whom will later accept service with them.

We should not forget that a right attitude of mind toward accidents is fundamental to successful industrial accident prevention and that the most effective and certain way to obtain it is through education and training during childhood. The industrial executive, therefore, is, or should be, directly concerned in stimulating the teaching of safety in the elementary schools.

The advantage of occasionally inviting the families of employes to general plant safety meetings or "rallies" has already been explained in a preceding chapter. Next in importance is the placing of "safety literature" in the employes' homes. The best material available for this purpose is undoubtedly the *National Safety News*, issued monthly by the National Safety Council. It is a desirable magazine for the shelves of the local public library, employes' clubs and Y. M. C. As., but superintendents, foremen and central safety committee members should also receive it in their homes where there is leisure to peruse it and where the wife and children may become interested.

The National Safety Council also produces each year a 12-page *Safety Calendar* which is sold at low cost. Safety-in-the-home booklets are also obtainable. Either or both are valuable as a medium of propaganda in the home and can be sent by the executive to each employe without incurring undue expense. Many employers, both large and small, have adopted this prac-

tice, over 500,000 calendars a year being ordered for this purpose by members of the National Safety Council.

Participation in accident prevention activities, conducted outside the place of employment, should be encouraged. If there is a local "Safety Council" or similar organization, employes should be encouraged to take an active part in it and attend its meetings and "Foremen's Safety School." Participation in public accident prevention work, water life-saving or the first-aid classes of the local chapter of the American Red Cross helps to accentuate interest in the plant's own safety efforts.

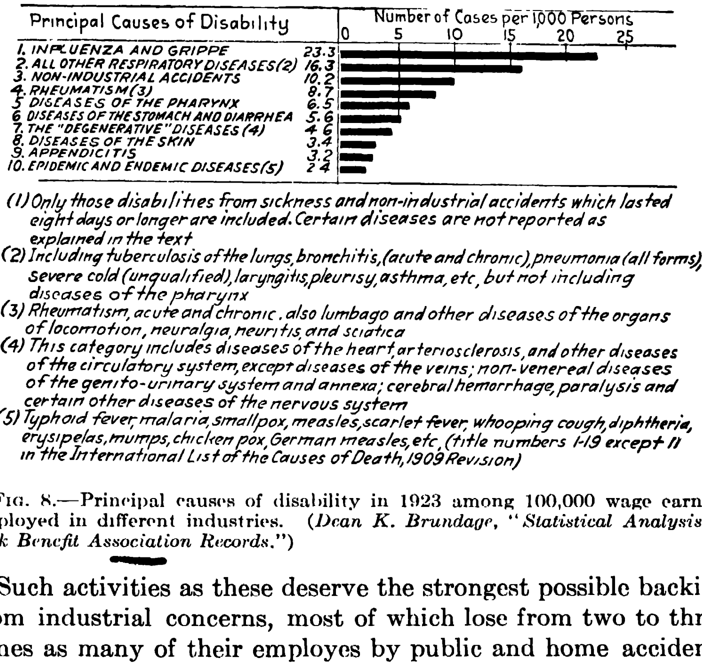


FIG. 8.—Principal causes of disability in 1923 among 100,000 wage earners employed in different industries. (*Dean K. Brundage, "Statistical Analysis of Sick Benefit Association Records."*)

Such activities as these deserve the strongest possible backing from industrial concerns, most of which lose from two to three times as many of their employes by public and home accidents as are lost by accidents occurring within the plant. In the experience of 100,000 wage earners, shown in Fig. 8, non-industrial accidents stand third in the causes of disability with a frequency of 10.2 cases per 1,000 persons.[1] The subject is therefore doubly deserving of the attention of the progressive employer who is interested not only in his employes' welfare but in maintaining the integrity of his working force.

[1] BRUNDAGE, DEAN K., "Statistical Analysis of Sick Benefit Association Records," *Proc. Nat. Safety Council*, Thirteenth Annual Safety Congress, p. 418, 1924.

# CHAPTER XX

## SAFETY AND PRODUCTION—THE EQUIPMENT FACTOR

"A safe plant is an efficient plant." This statement is found among the earliest writings on organized accident prevention. Although its full significance was probably not understood—in fact, it is not generally understood today—it appears to have been accepted without question and was later adopted into the creed of the safety engineer.

The reason for its early acceptance is not hard to conjecture. It was obvious, then, as it is today, that accidents which caused physical injury interrupted the manufacturing process, occasioned lost time from work and disturbed the whole organization. Plants with notoriously bad accident records, moreover, were dubbed "slaughter houses" and were avoided by the better class of workmen, thus forcing their managers to employ an inferior grade of labor. In some occupations, hazardous or unhealthful, only unskilled foreigners would work, the poorest grade of immigrant labor: "wops," "polacks" and "hunkies." These were unintelligent and inefficient producers, unstable, and, by reason of their high turnover, contributed liberally to employment expense, damaged equipment and wasted materials.

Although other factors also affected the situation, a bad accident record always helped to make matters worse. This the intelligent plant manager realized, however dubious he might feel about the possibility of reducing the accidents themselves, for in those days loss of life through accidents was very generally considered a necessary part of the price paid for industrial progress. Each additional mile of railroad track, each floor added to the structure of a "skyscraper" was expected to take its toll of the workers. Only the idealist believed that this tax could be evaded; the practical man regretted it and at the same time realized that accidents interfered with the efficiency of his operations.

**Theory of Relationship.**—The first real summing up of the case of accidents versus production efficiency seems to have made its

appearance in an article entitled "How Can We Increase Production?" in the July 3, 1920, issue of the *National Safety News*. The conclusions of its author, Sidney J. Williams, then Secretary and Chief Engineer of the National Safety Council, are contained in the following quotation:

It is plain that, from the standpoint of industry, a coal strike is unexpected and is therefore an accident; a breakdown of a power plant is unexpected and is therefore an accident; the sticking of material in a press is unexpected—not contemplated or desired by the designer of the machine—and is therefore an accident, whether anyone happens to be injured or not. In short, "accident" in the broad meaning given by the dictionary is exactly synonymous with all the disturbing things which interfere with production; it is the exact opposite of production efficiency . . . Some of the "accidents" . . . some of the things which happen unexpectedly . . . result in personal injury.

From the standpoint of men interested only in production, the accidents which happen to injure someone are no more and no less important than those which do not . . . Accidents and efficiency are absolutely incompatible; they cannot exist in the same plant; the plant where things are permitted to happen unexpectedly is an inefficient plant.

In subsequent contributions Williams developed his hypothesis further. As illustration, he cited the case of a hand truck from which a casting fell and injured the operator's foot. He pointed out that the accident, if it had no unusual features, would probably be thought unworthy of special investigation and the truckmen would merely be warned to be more careful in the future. Such advice, he noted, if heeded, might lead to more careful operation—probably to slower operation; this, in turn, might be followed by orders from the foreman to speed up the trucking, thus making the safety effort abortive and productive of further injuries. On the other hand, if a careful investigation had been made, it might have disclosed the fact that castings were continually falling off trucks even though they only occasionally injured someone. A careful determination of the cause of their falling might be important from its bearing on future prevention. Possible causes would be numerous: broken or uneven floors, defective trucks, improper type of truck, too great a load, load improperly piled, congested or obstructed aisles, or insufficient light.

The point stressed by Williams did not relate to methods of prevention, but to the unsuspected effect of accidents on the

transportation schedule. He pointed out that each time a casting fell, the normal functions of the truck and its operator were suspended while it was being picked up and replaced. This might even require the assistance of another man, besides congesting the aisle, and would perhaps delay the work of men who were awaiting the delivery of the castings. He suggested that the aggregate loss of time of all those directly or indirectly affected might be considerably greater than one would surmise and that, if such accidents continued day after day, the total lost time might materially exceed the injury disability.

Applying this reasoning to general industrial conditions, Williams conjectured that some, and possibly all, industrial injuries might be mere physical symptoms of the existence of inefficient industrial processes. Removal of the basic causes of such injuries, he pointed out, would in that case probably remove the causes of the concomitant inefficiencies.

**Application of Theory to Power Transmission.**—Let us undertake to apply Williams' hypothesis to specific industrial conditions. In the case of power-driven machines, the output of which is directly dependent on the continuity of their operation, it is quite obvious that any circumstance which interrupts operation must necessarily diminish the output. The same is true of the transmission equipment which furnishes the power for the machines, except that any interruption of a group or shop drive will cause greater production losses since it will affect simultaneously the operation of a number of machines. A similar though more serious result will follow the interruption of the power supply or generating equipment.

Momentarily at least, the circumstances causing the interruption will increase the probability of injury occurrence. It may be a recognized accident, such as the breaking of a driving belt, in which case the possibility of physical injury is manifest, or it may be such a common occurrence as to be regarded as a mere incident in the day's work, such as a belt riding off a pulley. Incident or accident, the hazards are thereby increased.

The mere replacement of a belt may lead to serious injury or even a fatal accident. Furthermore, the belt itself, its guard or some other part of the equipment, may be damaged. To prevent its happening again, an employe may erect a piece of board to keep the belt in place and this may later be caught by the belt and thrown, or fall into the belt and wreck the pulley

or be ignited by friction and set the shop on fire. Such eventualities are by no means uncommon in industrial accident experience and often arise from a remediable cause as trivial as the breaking or unshipping of a belt.

There is a third class of occurrences which, though not causing an absolute interruption, may slow down or otherwise interfere with regular operation. One of the simplest examples is the slipping of a belt on its pulley due, perhaps, to the use of a belt which is not wide enough to carry its load. Such slipping would somewhat lower the speed of the driven machines and so decrease their rate of production. Slight as this loss might seem to be, it would be continuous and cumulative and might prove to be of more serious consequence than an occasional complete interruption. Furthermore, the life of the belt would be diminished, perhaps as much as 50%. Since it would also be more apt to leave the pulley suddenly, the possibility of injury or property damage would be above normal. The common remedy for a slipping belt is an application of belt-dressing, usually applied with a stick as near as possible to the "bite" of the moving belt and pulley. Many men have been injured in doing this, and sometimes belts or pulleys have been broken when the stick was caught.

The possible causes of belts breaking, coming off or slipping on their pulleys are many, but they are frequently traceable to lack of proper supervision in design, operation or maintenance of the equipment—in other words, to the fact that, at the moment, the belt is unable to carry its load. This is by no means an exceptional condition in industrial establishments; in fact, the amount of disregard for the condition of belt drives is little short of amazing.

A carefully conducted belt survey of plants of the duPont Company by its belting and transmission engineer, William Staniar, involving tests on as many as 150 belts at one time, and followed later by changes in the equipment, yielded surprising results. In particular instances the life of belts was increased from 9 to 154 days, 30 to 60 days, 4 months to 9 months and 1 year to 2 years with corresponding reduction in maintenance expense and increase in production due to fewer shutdowns. As a result of the knowledge gained by this comparative testing, the shutdowns in one building were decreased from 83 in 30 days to 29 in 60 days. In another building where trouble was

being experienced with the capacity of the grinding equipment driven by a certain brand of belting, it was possible to correct the fault and increase the capacity 40%. The entire survey cost $200 but resulted in a direct saving of $7,000, aside from increasing production.[1]

In the cases just cited there is no question that the probability of physical injury from conditions arising directly or indirectly out of the belting situation was reduced at the time the improvements were effected. We know that the adjustment of belts, particularly by the unskilled, is hazardous. The high, relative frequency of injuries from this source is brought out in the Massachusetts experience quoted in Table XI, about one-half the reported belt accidents having happened during "adjustments."

TABLE XI.—REPORTED BELT INJURIES IN MASSACHUSETTS JULY 1, 1923 TO JUNE 30, 1924

| Manner of occurrence | Number of injuries |
|---|---|
| Adjusting | 184 |
| Starting, stopping or operating | 56 |
| Cleaning or oiling | 47 |
| Repairing | 8 |
| Breaking | 53 |
| Flying objects | 1 |
| All others | 12 |
| Total | 361 |

Commonwealth of Massachusetts, *Public Document* 105, *Annual Report of the Department of Industrial Accidents for the Year ending June 30, 1924*, Table XI.

To this we may add evidence on severity from Wisconsin's experience in 1923 which shows a very high frequency of death cases among belt accidents, being 6% of the reported cases, a rate exceeded only by "electricity" with 15.6% and "elevators" with 6.2%.[2]

[1] STANIAR, WILLIAM, "Standardization of Belting and Transmission Machinery, a Protection to Manufacturer, Jobber and Dealer," *American Machinist*, **60**, 26, p. 97, June 26, 1924.

[2] *Wisconsin Labor Statistics* (Wisconsin Industrial Commission), **3**, p. 8, 1924.

What has been said of belt drives is presumably applicable in principle to other forms of power transmission, since events which disturb the continuity of transmitted power must inevitably make for conditions favoring the occurrence of accidental injury. This is not necessarily confined to mechanical power transmission. In the electrical fields, burns, "flashes" and even electrocutions are a not uncommon result of attempts to restore the operation of electric circuits that have momentarily ceased to function. In the transmission of liquids or gases, pipefitters are not infrequently burned, scalded or gassed while shutting off the flow in ruptured mains or otherwise repairing damage that has affected the supply.

Operators and repairmen of all sorts have been injured or killed in hundreds of different ways as result of circumstances arising out of interruption to the normal functioning of industrial equipment. In the year 1922, 60% of the severity rate of the Dye Works of the duPont Company was attributed by its manager to what he termed "emergency methods"—that is, conditions constituting a departure from the normal.

**Relation of Maintenance to Safety and Production.**—Any circumstance which interrupts the routine of normal operations and necessitates repairs not only curtails production but increases the probability of physical injury because of the peculiar and intrinsically greater hazards attendant on repairs. If the interruption is sudden and unexpected, the delay which it occasions is apt to be more prolonged and the danger of injury is likely to be increased, especially if repairs have to be made under pressure of anxiety to hasten resumption of normal work. If the word "maintenance" is used to imply a condition which tends to reduce the number of *unexpected* process interruptions or the extent of the subsequent repairs or replacements, it must at once be admitted that maintenance helps to sustain the optimum rate of production and the normal degree of safety. After all, maintenance is merely the preservation of the normal and expected as against the abnormal, unexpected or accidental.

Table XII shows an analysis of working conditions as they affected injury causation on plants of the duPont Company in 1923–1924. Almost 30% of these injuries occurred during other than normal work and one-third of them during minor repairs.

TABLE XII.—GENERAL WORKING CONDITIONS AFFECTING 473 TABULATABLE INJURY CASES REPORTED BY DUPONT PLANTS DURING 1923 TO 1924

| | Number of cases | % of total |
|---|---|---|
| Minor repairs | 49 | 10 6 |
| Oiling | 0 | 0.0 |
| Special adjustment | 2 | 0 4 |
| Construction or major repairs | 80 | 16 9 |
| Experimental conditions | 2 | 0 4 |
| Breakdown | 0 | 0 0 |
| Serious emergency | 7 | 1 5 |
| Normal work | 333 | 70 2 |
| Total | 473 | 100 0 |

Proper maintenance involves a great deal more than the mere making of repairs after breakdown and concerns itself with matters of engineering design, operating supervision and depreciation of the strength of equipment from normal use, wear, "fatigue" or deterioration in other forms. It is affected by the overload capacity of the plant in so far as provision has been made for periodically laying up operating units for examination, testing, adjustments, renewals and repairs which will obviate unexpected and more serious failures during normal operation.

L. P. Alford, editor of *Management and Administration*, and one of the members of the Federated Engineering Societies' Committee on Waste in Industry, writes:

Unfortunately plant maintenance is one of the most neglected parts of management work. Seldom do we find it organized as a preventive measure instead of a cure. I can easily imagine, however, that with an efficient maintenance department equipment can be kept in first-class condition no matter how many hours it may be used per day or how severe the overload may be.[1]

As far as the author's experience goes, the so-called "maintenance department" of the average plant is usually merely a repair department, as Alford points out. This defect is probably attributable not so much to the shortcomings of the depart-

[1] Personal correspondence, Aug. 3 1925.

ment itself as to the shortsightedness of the management, which fails to apply the lesson of the homely adage, "A stitch in time saves nine."

Even in processes where the rate of depreciation is high, for example in chemical plants, no card history of individual pieces of equipment giving the frequency and cost of repairs is usually kept, notwithstanding the value of such records as a source of information from which to determine when replacement with more efficient or safer equipment is economically justified, what parts should be inspected, what defects they should be inspected for and how frequently inspections should be made. In default of such records, inefficient units are allowed to continue in operation, often with loss of production and high repair costs plus an added hazard to operators. Periodic inspections are often neglected, being usually confined to externally fired pressure vessels (such as boilers), elevators, cranes and other hoisting appliances and flywheels—all equipment originally designed with high factors of safety and not particularly subject to unexpected breakdown under normal use. Otherwise, it is left to the operators who are not engineers, or even mechanics, to report anything wrong with their machines. As a natural result, repairs are made after, rather than before, a breakdown, and replacement with new and better equipment is brought up for consideration only when further repairs seem to be out of the question.

Civilization seems to be gradually learning that health preservation is better than health neglect followed by curative medicine and surgery; we may conjecture that the industrial world will also learn that physical maintenance is better than physical neglect followed by major repairs. When this comes about, we may expect to find fewer repairs, injuries and breakdowns of the magnitude of catastrophes. Both production and safety will be benefited.

**Safety and Efficiency in Use of Tools.**—In a manually fed cutting tool, such as the circular ripsaw, the optimum cutting rate depends not only on the material being cut but on the speed and condition of the tool. The latter is very important. Dull cutting tools, whether machine or manually operated, not only will not do their work efficiently but are more dangerous than sharp tools. Every man knows that this is true of a dull razor or a dull hatchet.

Equally important is the *set* which permits the tool to clear itself as its cut progresses, and get rid of the waste material such as sawdust, chips or shavings. Improper or insufficient *edge* or *set* retards cutting by increasing the friction and thereby the power required; it creates a natural tendency on the part of the operator to force the tool to do its work, thus subjecting both it and him to unnecessary strains; it tires and provokes him, distracting his attention from the work itself and rendering him more liable to injury; it is likely to cause the material or tool to jam or bind, which in some situations may be dangerous.

Anyone with woodworking and machine-shop experience will recognize the truth of these statements, and many will have witnessed accidents caused by the jamming of a worn twist drill (so that the work was pulled from its clamps crushing the hand of the drill-press operator), or the unexpected kickback of lumber from a circular saw. In connection with the latter tool, the following quotation is of interest:

The tabulation of injuries, caused by machinery in factories, made by the New York State Industrial Commission, shows that in the class known as "Working Machines," there were 45,699 injuries in a period of 3 years, being 76.6% of all injuries reported due to machinery. Seventy-nine of these injuries were fatal.

Woodworking machines caused 6,336 out of a total of 45,699 injuries due to working machines. Saws were responsible for 3,798 injuries and 27 of the 79 fatal injuries due to all working machines. In addition to this large percentage of fatal injuries, they have a record for dismemberments. This proves that power saws are conspicuous among all the working machines, with the highest record for fatal injuries and a large percentage of dismemberments.

Many of the so-called accidents are charged to carelessness on the part of the operator, when in fact the fault lies in the ignorance or neglect of the employer or operator. Experience shows that, if all working machines were kept in proper working condition by experienced persons, the number of industrial injuries would be greatly reduced.

One of the largest concerns manufacturing saws in this country states, in its catalogue, that one-half of the saws sent back to the factory for repairs have been injured or ruined by the neglect of the owner or operator, who, although knowing how to properly fit saws, fails to reset or sharpen the saw, as long as he can force the same through a cut of any kind.[1]

[1] GERNON, JAMES L., "Preventing Injuries Due to Power Saws, by Their Proper Care and Use," *Bulletin of the New York State Industrial Commission*, **1**, 12, September, 1916.

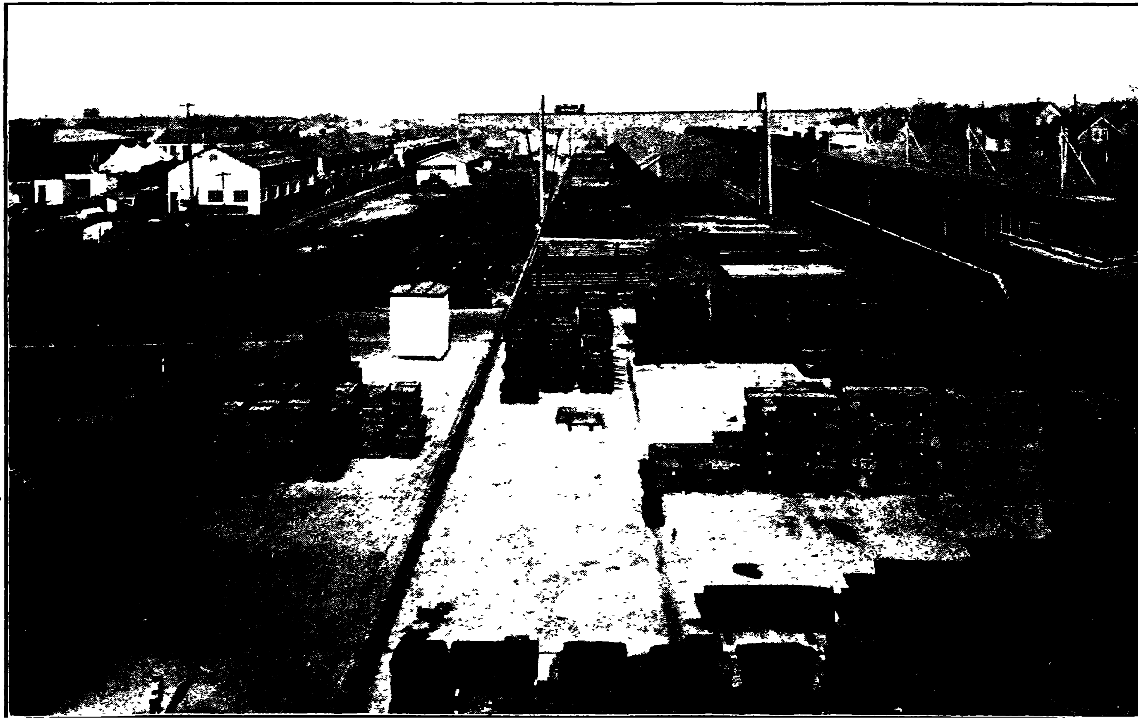

Plate XV.—Orderly Storage Yard—Fairbanks Morse and Company. (*National Safety Council.*)

(*Facing page 218*)

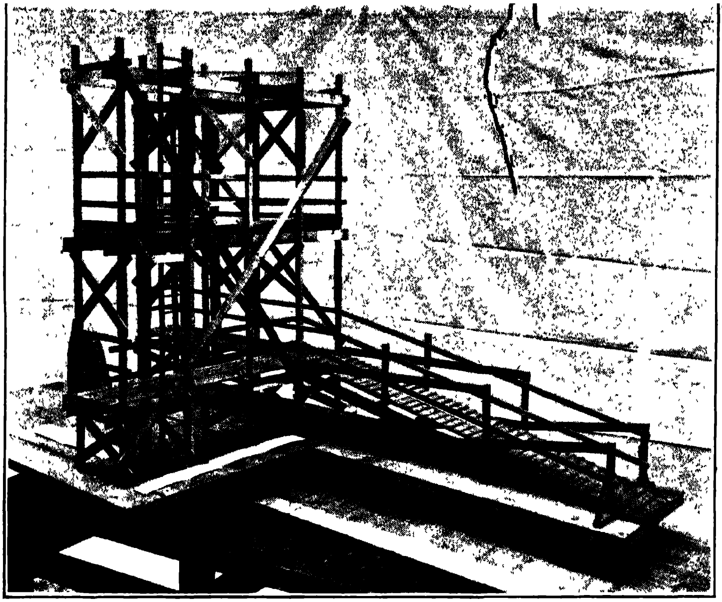

PLATE XVIa.—Model Scaffold for Instruction of Construction Foremen. (*E. I. duPont de Nemours and Company.*)

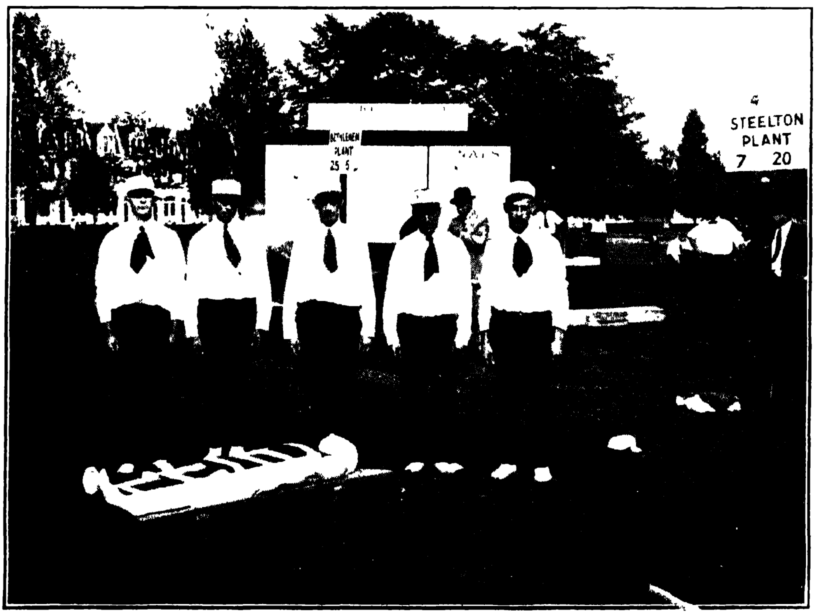


PLATE XVIb.—First Aid Contest—Bethlehem Steel Corporation. (*Nati... al Safety Council.*)

(*Facing page 2*

It seems almost unnecessary to point out the effect of edge and set on the production efficiency of cutting tools. It is too obvious to require emphasis, yet dull and improperly set tools are by no means rare. Henry Schreiber, Deputy of the Industrial Commission of Wisconsin, is authority for the statement that changing woodworking saws when dull would reduce saw accidents 75% and at the same time increase production, and this regardless of existing guards. On the other hand, he explains the relatively few injuries caused by shapers and similar manually fed woodworking tools which give a *finished* surface by pointing out that they *must* be kept sharp in order to turn out a satisfactory product.[1]

The importance of sharp and properly set tools is probably recognized in large shops where tool dressing is systematically attended to in the toolroom, but even in these establishments one often finds little attention paid to many different sorts of implements upon the good condition of which their working efficiency as well as the safety of their user depends. While sharp, cold-chisels may be found in the toolroom, the garage mechanics, the pipefitters and the "handy man" have cold-chisels that would be discreditable to a farmer. No mushroomed tools are permitted in the machine shop, but the blacksmith (the very man who dresses the tools on a small plant) allows his own tools to become so mushroomed that they would not be tolerated elsewhere.

Many plants overlook the sharpening of electricians' spurs and pike poles, bale hooks, cant hooks, ladder spurs and other implements. The primitive crowbar, reasonably sharp when purchased, almost never receives attention. Many a pipefitter has been injured or killed primarily because his wrench slipped, yet every safety inspector will agree that open-end wrenches with spread jaws and Stillsons with worn or broken teeth outnumber the good wrenches two to one.

Few seem to realize that each time a wrench slips, human effort and time that is being paid for by the employer is lost, whether an injury results or not. The 10-penny nail that flies off under the carpenter's hammer, the face of which has been worn and chipped, is usually a total loss as well as the hammer stroke itself. Such losses are, in themselves, insignificant, but in the aggregate may compose a significant item of expense. When

[1] *Proc. Nat. Safety Council*, Ninth Annual Safety Congress, p. 1327, 1920.

the flying nail strikes an unprotected eye and the eye is lost, something truly significant has happened, but why, indeed, should we wait for its maturity when we know that it can take place? About one thousand new hammers can be purchased for the compensation cost of a single eye!

Another source of combined waste and danger lies in the use of improper or improvised tools. The man who uses a Stillson instead of a safety wrench to release the gates of a hopper-bottom coal car consumes more effort and at the same time seriously endangers himself. A hatchet is an ineffective implement for drawing nails and, when used for this purpose, the handle can be readily broken and perhaps result in a fall from scaffolding. The painter who works on an unsteady ladder probably wastes more time in uncertain work or in maintaining his balance than it would take him to make his ladder reasonably secure. Implements and the technique of their proper use have evolved out of a background of improvisation and experiment. The implements available today have been adopted into general use because they have proved to be the most *efficient and safest* for the purpose intended.

Inefficiency and danger are often present in the employment of what are described as "universal" or "all purpose" tools. The hatchet is an example, for, although it may be a good hatchet, it is inherently a poor hammer and a poor nail extractor. Another example is the circular saw of the small shop that is used for many jobs that could be more efficiently and safely performed on tools designed for the specific purpose. Because some element of safety is sacrificed to attain its all-purposefulness, it has so far been found impossible to design for it an effective universal guard; indeed the most effective guard seems to be one that can be removed, replaced and adjusted with the least inconvenience. Similarly, a good knife and a good screw driver are more efficient and safer to use than a pocketknife with screw-driver blade, and a good can-opener and a corkscrew are better than the combination implement, the use of which presents certain hazards of its own in addition to those of its component parts.

Inefficiency and danger are apt to reside in the use of primitive implements or methods. An example of an archaic—or at least Archimedean—device is the screw and bar still in use for setting up various types of large presses. This device on filter presses at the Dye Works of the duPont Company caused numerous

injuries such as strains, ruptures and broken or bruised fingers or toes. It sometimes required four men to set up a large press. The substitution of geared mechanism actuated by a hand wheel paid for itself by reducing the number of men required to one, or at the most, two, and at the same time accidents from this source were apparently eliminated.

**Safety and Production Efficiency in Repetitive Machines.**—More definite advance in safety and production efficiency seems to have been made in the operation of power presses than any other type of machine. Some of the most illuminating information comes from August L. Kaems of the Simmons Company, Kenosha, Wis.[1] After pointing out that on jobs where the work had to be set by hand the operators' fingers entered the danger zone as often as 16,000 times a day, Kaems describes the substitution of slide or chute feeds, sometimes with the addition of special strippers, kickouts or other arrangements to remove the finished pieces. He cites an instance of output increased from 3,000 to 3,500 pieces per press per day to 7,200 by changing from hand setting to the use of slide feeds. In another case output was increased 150% by a slide and an improved stripper. One change that cost $25 saved $1,800!

In 1919 when there were 700 presses operating in one department, 36 fingers were taken off in accidents. With the above changes in the method of operation the injuries decreased to seven fingers during the first 6 months of 1920. In the 4 years following, *not a single finger was lost* and the production per press had increased on the average 60 to 65%. Kaems says, "Our experience has been that whenever we made a job safe we also increased the production from 15 to 150%."

Such remarkable records as the foregoing merely prove what is, after all, almost self-evident: that production is increased when unnecessary motions are eliminated, and injuries are decreased when motions that involve exposure to hazards are eliminated.

Williams has stated, "The best way to guard a punch-press operation is not to guard it at all, but to use safe methods of feeding."[2] He has also cited[3] the installation of a foot-operated

[1] *Proc. Nat. Safety Council*, Ninth Annual Safety Congress, p. 441, 1920; Tenth Congress, p. 172, 1921; Eleventh Congress, p. 162, 1922; Twelfth Congress, p. 180, 1923; Thirteenth Congress, p. 154, 1924.

[2] Williams, S. J., *Proc. Nat. Safety Council*, Ninth Annual Safety Congress, p. 181, 1920.

[3] "Waste in Industry," p. 334, McGraw-Hill Book Company, Inc., 1920.

kickout on presses used for stamping canteens during the war, which was objected to at the time by the War Department's representative, but which promptly justified itself by practically doubling the output. F. J. Littell mentions[1] an instance in which replacing hand feed with dial feed made a press operation entirely safe and at the same time increased production 150%.

A case worth quoting occurred at the Newburgh plant of the duPont Company in presses used for embossing Fabrikoid, a leather substitute. For 15 years this was a slow, treadle-actuated, two-man operation done at an average rate of five impressions per minute. Occasional accidents during this period, in which operators lost practically an entire hand, led finally to the development of guards that did not interfere with the required adjustment of the goods, so that successive impressions registered exactly. With this change it was found possible to increase the operating speed to nine impressions per minute and, later, operate with one man per press. The further development of a satisfactory automatic wind-up again increased safety and permitted one man to operate two presses. Through these changes accidents were eliminated, labor reduced 75% and production per press increased 80%.

In power-driven machines which are repetitive but do not operate continuously—in other words, require to be tripped by hand- or foot-actuated devices, it is obvious that unnecessary motions during which the hands have to be brought into the danger zone are both wasteful and dangerous. In high-speed machines that are repetitive but operate continuously, manual feed is practically out of the question and the chief source of danger is from unexpected operation after the machine has been stopped temporarily for adjustment, for removing jammed stock, or for other purposes. As production ceases during these shut-downs and certain hazards are created, anything which will diminish their frequency will be reflected in both production and safety.

**Relation of Speed to Safety and Production.**—There is probably no great difference in hazard between production forced beyond normal for a new machine and "keeping up production" on a machine that is depreciating rapidly. In either case the process of forcing usually induces interruptions and accidents which, though increasing the rate of production, may actually

[1] *Proc. Nat. Safety Council*, Twelfth Annual Safety Council, p. 174, 1923.

diminish the average daily output. H. A. Coffin of the Cadillac Motor Company mentions a case where production was increased 30% at the expense of a 100% increase in accidents,[1] and there are probably innumerable instances where forcing the normal output has been disastrous.

In the iron and steel industry, Chaney tells us that "The evidence of laboratory test and mill experience is to the effect that sudden increments of speed are accompanied by greater accident frequency."[2] According to H. M. Vernon, "Speed of production is the essential factor in accident causation."[3]

A later, though somewhat more circumscribed opinion, based on careful studies of actual working conditions during the war, is, "In the absence of fatigue, accidents vary directly with speed of production, owing to increased exposure to risk."[4] This latter statement seems to be based on sound deductions and probably expresses the true situation. These authorities, however, judging from the context (which space does not permit us to quote), had in mind the effect of speed upon the operator, through increased exposure or fatigue, rather than upon the safety or life of the operating equipment. It is the latter with which we are chiefly concerned in this chapter.

Overspeed, that is, speed too high for safety, is the consequence, it may be presumed, of a desire to produce a greater output without giving the situation adequate engineering revision. The bad effects of this should be reflected in the frequency rate, but even more in the severity rate, since mechanical accidents are notoriously severe. After a study of the causes of 372 fatal accidents in iron and steel plants, Chaney concluded that in only 10% of the cases was the man's own carelessness a major factor, while 57% could have been prevented through "engineering revision."[5] The results of the study on which his conclusion was based are presented in Table XIII.

[1] *Proc. Nat. Safety Council,* Twelfth Annual Safety Congress, p. 174, 1923.

[2] "Causes and Prevention of Accidents in the Iron and Steel Industry 1910–1919," *Bull.* 298, U. S. Bur. of Labor Statistics, p. 168, 1922.

[3] "An Investigation of the Factors Concerned in the Causation of Industrial Accidents," Health of Munition Workers Committee, *Memo.* 21, London, 1918.

[4] Goldmark and Hopkins, "Comparison of an Eight-hour Plant and a Ten-hour Plant," U. S. Public Health Service, *Bull.* 106, p. 100, 1920.

[5] "Causes and Prevention of Accidents in the Iron and Steel Industry, 1910–1919," *Bull.* 298, U. S. Bur. of Labor Statistics, p. 199, 1922.

TABLE XIII.—CLASSIFICATION OF ACCIDENTS BY SAFETY COMMITTEES OF A STEEL COMPANY, 1915 TO 1916

| Class of accident on basis of disability | Number of cases of disabling accident preventable by | | | |
|---|---|---|---|---|
| | Engineering revision | Care of worker | Trade risk | Total |
| Six weeks and under | 56 | 973 | 381 | 1,410 |
| Over six weeks | 16 | 100 | 48 | 164 |
| Death and major mutilation | 39 | 10 | 19 | 68 |
| Total | 111 | 1,083 | 448 | 1,642 |
| | Percentage distribution | | | |
| Six weeks and under | 4 | 69 | 27 | 100 |
| Over six weeks | 10 | 60 | 30 | 100 |
| Death and major mutilation | 57 | 15 | 28 | 100 |
| Total | 7 | 66 | 27 | 100 |

In passing, it should be noted that unsafe overspeed may be the result of a variety of factors, among them:

1. Pressure by management for increased production.
2. Piece-work rates.
3. Bonus for production above normal.
4. Effort to maintain previous rates despite changes in operating conditions or depreciation of operating equipment.

**General Plant Operations.**—There are probably innumerable instances where major changes made primarily for operating reasons or to offset depreciation or inefficiency of existing equipment have been followed by lower injury rates in the process affected. Indeed, one might hazard the statement that no plant is ever intelligently rearranged or rebuilt without the introduction of improvements which favorably affect production efficiency, conditions of work and safety.

Other factors, however, may offset or mask these good effects, especially during the period of adjustment to the new conditions. Such a one is the introduction of mechanical appliances replacing to a certain extent the human element. It has already been discussed in some detail in Chap. XVI. This change is going on today throughout the industrial world, stimulated by high wages,

at times by labor shortage, by scientific discoveries and by engineering development. Ethelbert Stewart, U. S. Commissioner of Labor Statistics, gives us an adequate picture of this situation in the following statements:

When labor is cheap, men are employed to do many things that are done by machinery when wages reach higher levels. The war worked marvels in the reorganization of industry.

A New England can-manufacturing plant announces that it has increased its production 100% by the simple routing of material, placing the machines in rows in the order of their place in the work of production so that the material simply glides from one machine to another instead of being trucked from one part of the plant to another as before. The whole question of trucking and assembling has been made mechanical and automatic.

A plant at Worcester, Mass., that employs 6,000 people is producing more goods with 600 fewer employes than it had before the war. Formerly the steel billets were carried by low-wage workmen from the stock pile to the initial piece of machinery. Now a huge magnet attached to a crane picks up tons of these billets at a time and swings them around where they are needed, one crane engineman doing the work of 66 men.

I was told by an official of the International Paper Co. that in one plant 48 coal shovelers have been replaced by three men who turn the valve to feed the fire boxes with crude oil, and that the difference in the wages very much more than compensates for the difference in the cost of the fuel.

Taking it all in all I estimate that 10% fewer men are performing the same work that was performed before the war. This of course means that the employment index of today stands for greater productivity than the employment index of 1914.[1]

Most of the successful attempts to stop the wastage of men have been accomplished by a simple readjustment of machines on the one hand or by means of either automatic conveyor devices or the installation of more efficient trucking and shop transportation methods, on the other hand. One automobile concern which advertised that its material from the time it entered the factory until it became the finished product traveled an average of 3½ miles, has within the last 6 months so readjusted its plant that its material travels but 50 feet. A plant in Louisiana which conveyed its product from the factory to the boat by truck has installed a conveyor which carries the material packed in crates

[1] "Employment Statistics," *Proc. International Association of Public Employment Services*, Eleventh Annual Meeting, *Bull.* 355, U. S. Bur. Labor Statistics, p. 20, 1924.

across a marsh from the factory to the dock and automatically discharges it into a spiral chute which carries it into the hold of the vessel without its being touched by human hands. By means of this one device, four men are now doing in a few hours each day the work formerly done by 100 men on a 12-hour-day-basis. It is admitted by those who have studied the subject without prejudice that this same device is applicable to every dock and every factory in the United States.[1]

Decreasing the number of employes or the number of hours worked in a given process decreases the total exposure to injury, but because mechanical processes are intrinsically more hazardous than simple, manual processes the injury frequency and severity rates may rise even though the exposure has diminished and the actual number of injuries has decreased in consequence. As already mentioned in Chap. VIII, from the standpoint of industrial production, the aggregate danger may have been lowered, but from the humanitarian standpoint, focused on the condition of the individual worker, the danger may have been increased. The mechanization of industry is undoubtedly resulting in improved production efficiency but on the man-exposure basis it probably tends to contribute higher injury rates.

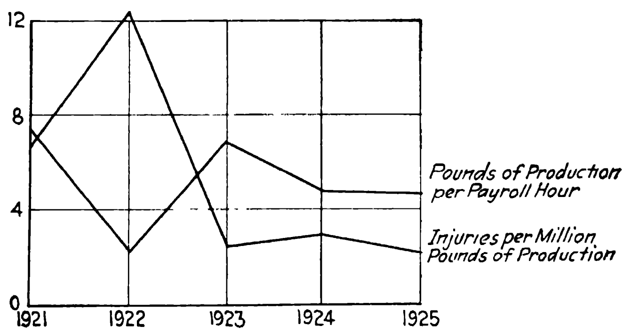


FIG. 9.—Production per payroll hour and tabulatable injuries per unit of production, Dye Works, E. I. duPont de Nemours and Company.

Since the war no line of manufacture has undergone more radical changes than the chemical industry. In many of its branches and particularly in the manufacture of dyes, it has been necessary to introduce constantly new manufacturing methods

[1] "Wastage of Men." *Monthly Labor Rev.*, U. S. Bur. Labor Statistics, **19**, 1, p. 4.

and abandon equipment and processes that had become obsolete or otherwise unsuitable, sometimes within a single year. Often there was no information available on the degree of injury or occupational disease hazard in the new process other than a meager knowledge gained in the laboratory. Recent accident experience in the dye industry therefore largely reflects the effects of process changes made primarily to obtain better quantity or quality yields, higher production efficiency or lower manufacturing costs.

In Fig. 9 is given the experience of the Dye Works of the duPont Company, a plant employing about 1,500 men and operating a large number of diverse chemical processes. The curves show the number of injuries per unit of production and the production per man employed. Their relative variation, their reciprocal relationship is of particular interest to us at this point.

TABLE XIV.—PRODUCTION AND OCCUPATIONAL POISONING IN THE MANUFACTURE OF DINITROBENZOL, DYE WORKS, E. I. DUPONT DE NEMOURS AND COMPANY, 1918 TO 1924

| Year | Number of daily shifts | Number of operators per shift | Number of poisoning cases | Hours lost through poisoning | Production, pounds | Production, pounds per working hour | Hours lost per 1,000 pounds of production |
|---|---|---|---|---|---|---|---|
| 1918 | 1 | 4 | 19 | 582 | 52,640 | 10.6 | 11.1 |
| 1919 | 2 | 4 | 39 | 808 | 549,452 | 27.7 | 1.47 |
| 1920 | 3 | 2 | 18 | 736 | 732,909 | 73.7 | 1.00 |
| 1921 | 1 | 2 | 0 | 0 | 7,272 | 152 | 0 |
| 1922 | 1 | 2 | 0 | 0 | 363,892 | 74 3 | 0 |
| 1923 | 1 | 2 | 0 | 0 | 553,870 | 183 | 0 |
| 1924 | 1 | 2 | 1 | 48 | 368,434 | 131 | 0.13 |

In several separate operations in this plant, production has been increased as much as 100% in 1 year coincident with a reduction in the number of injuries (including poisoning cases) to one-half. A typical experience is shown in Table XIV which presents statistics covering the manufacture of dinitrobenzol, an intermediate having a very bad reputation for its poisonous qualities. The principal changes introduced in this process were the installation of a neutralizing tank to absorb the escaping fumes and a pelleting machine to replace the former filtrose bed from which material had to be shoveled into barrels by two men. These men were severely exposed to poisoning, but after the installation of the machine their employment became unnecessary. The results are reflected in the figures.

## CHAPTER XXI

## SAFETY AND PRODUCTION—THE HUMAN FACTOR

"Accidents," says P. Sargent Florence, "are often enough accepted as a dispensation of Providence. This may be true of earthquakes, volcanic eruptions, storms and tempests, but in the humanly created conditions of industry, accidents must take their place beside turnover, lost time, and deficient and defective output as a symptom of human inefficiency."[1]

In the last analysis, it is on human intelligence that we must rely for accident prevention. The efficacy of all preventive and protective measures is conditioned upon what is termed "safety education," and safety organization itself is fundamentally a medium for educating and training the adult mind in habits of safety. The human element is, therefore, the dominant factor in our problem.

The mental and physical equipment of the individual employe, its condition, direction and application practically control industrial production; a manufacturing process that is mechanically efficient may be rendered grossly inefficient by inept or unintelligent management or by careless or unskilful operation. The human factor is, therefore, of paramount importance in both accident prevention and industrial production, and any lowering of its effective values may be expected to affect both safety and output.

**Mental Aspects.**—Boyd Fisher[2] lists the following mental causes of accidents:

| | |
|---|---|
| Ignorance | of English.<br>inexperience.<br>mental limitations. |
| Predispositions | sense defects.<br>mental sets—faulty attitudes—excitability.<br>subconscious errors.<br>faulty habits (hurry). |

[1] "Economics of Fatigue and Unrest," p. 274, Henry Holt and Company, 1924.

[2] "Mental Causes of Accidents," p. 22, Houghton Mifflin Company, 1922.

| | |
|---|---|
| Inattention | boredom.<br>distraction. |
| Preoccupation | worry—strife.<br>mental disease. |
| Depression | disease.<br>drugs, drink, etc.<br>faulty plant conditions.<br>energy blockade (so-called fatigue). |

A few moments' expenditure of thought on this table will convince the reader that there is not a single one of the listed causes which does not tend also to lower the industrial efficiency of the individual, no matter what his occupation. It will be further noted that many of these mental conditions would affect his industrial efficiency constantly rather than occasionally. Mental limitations, sense defects and mental diseases, for example, would exert their subversive influence throughout the course of his employment, regardless of the nature of his occupation.

**Ignorance and Inexperience.**—We should expect high injury rates among the illiterate, non-English-speaking classes and this seems to be generally confirmed by such statistical information as is available. From studies of the 1906 to 1913 experience of a large steel mill Chaney[1] reported a frequency rate for non-English-speaking employes of 67.8 per million hours' exposure against 30.8 for English-speaking foreign born and 28.0 for American born. The severity rate he found to be 7.5 (per thousand hours' exposure) for the non-English-speaking as against 6.8 and 5.3 for the other classes.

While such a comparison should not be accepted at absolute face value, since to the lot of the non-English-speaking classes falls the least desirable and often the more hazardous work, the greater liability of foreigners to accidental injury is generally admitted as well as their relatively low productive efficiency. How much of this is caused by true ignorance and how much is attributable to defects in the system by which foreign labor is put to work and supervised, it is impossible to say. Ignorance of the English language, while a serious obstacle to acquiring individual proficiency, is probably not as vital a factor in itself as unfamiliarity with the work and the conditions of work The

[1] "Causes and Prevention of Accidents in the Iron and Steel Industry, 1910–1919," *Bull*, 298, U S. Bur. Labor Statistics, p. 176, 1922.

latter is encountered in all new employes. In some localities and in some industries the employment of non-English-speakers is more or less avoidable while the problem of the new man is always present because of the inevitability of some degree of labor turnover.

In Chap. XVI the employment of the new man has been discussed in some detail and, in particular, his effect on injury frequency. Let us now consider his effect on plant production. In Fig. 10 is reproduced a chart due to Chaney[1] showing the fluc-

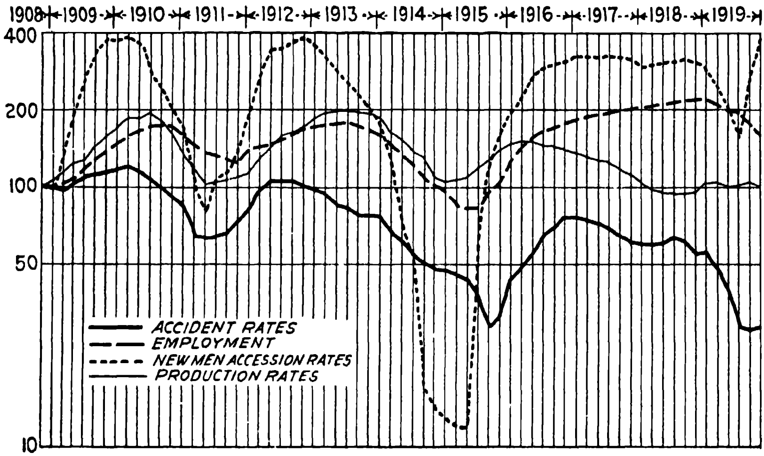


Fig. 10.—Relation of unemployment, accession of new men, and production to accident occurrence in a large steel plant. (*Bull.* 298, *U. S. Bur. Labor Statistics.*)

tuations of employment, new-man accession rates, accident rate, and production per man for a large steel plant in 1908 to 1914, plotted for the purpose of comparison on a percentage scale commencing with the arbitrary figure of 100 in 1908.

It will be noted that the best per-man productions was obtained, in general, after the rate of accession had commenced to fall. At that time three factors tending to increase the per-man production were probably at work: accession of relatively fewer unskilled men, selective discharge (tending to retain the better men) and voluntary individual effort to hold the job. All three of these factors tended also to reduce accidents and it may be

[1] *Ibid.*, p. 170.

conjectured that the injury rate decreased largely in consequence of them.

In a recent discussion of the subject "Are Accidents Increasing," at a joint meeting of the American Association for Labor Legislation and the American Statistical Association,[1] the relation between industrial accident frequency and employment was given emphasis by all the speakers. The general consensus of opinion was that increasing injury rates naturally accompanied marked increases in industrial business because of increased employment and the accession of new men, and that when business fell off the injury rates decreased. United States Commissioner of Labor Statistics, Ethelbert Stewart, stated:

> In every recovery from a depression large numbers of new men are taken on and the accident rate for new men is always very much greater than for employes older in point of service . . . There is a general speeding up of workers, both skilled and unskilled, a production per man-hour increase which registers a greater number of accidents, and this would probably especially affect the accident rate among new men.

From these and similar statements made elsewhere by recognized authorities and from our own observation we may conclude that the net effect of diluting an industrial establishment with new men is to increase accident rates and decrease the per-man production rate. The less there is of ignorance, inexperience and mental limitations in this new element, or the faster such handicaps can be overcome, the better will be the plant's experience in both safety and production, especially during periods of high labor accession. This calls for efforts appropriate to the rate at which new men are being acquired. Isaiah Hale, Safety Superintendent of the Atchison, Topeka and Santa Fe Railroad, states:

> No analysis of the causes of personal injuries should be attempted without keeping in mind the fact that there are certain types of men who are especially prone to mental failure. Safety instructions given the first day of a man's employment, as valuable as they can be, are absolutely wasted unless they are repeated often enough for him to know. Telling a man a thing once does not make him know it: knowing is a condition of *his* mind and not of the mind of the man who is telling it to him.

[1] Nineteenth Annual Meeting of the American Association for Labor Legislation, New York, Dec. 30, 1925.

Until you have broken down a new man's resistance to helpful information on the score of inexperience or ignorance, you must consider that man an accident risk. If a new workman gets off to a bad start and forms bad working habits, he must unlearn all that he has learned wrong. You will agree that good working habits can be made a factor in efficiency as bad habits can be made a factor in inefficiency and with proper training, good working habits are just as easily formed as bad ones.[1]

**Sense Defects.**—Relative to physical examinations for employment, Fisher states:

> It is surprising, however, that so little attention has been given to sense defects, which, while they have a less obvious bearing on compensation, exert a very positive influence on accidents. Even physicians, perhaps, continue to think of us as having only five senses. Almost every layman, of course, would say that hearing, seeing, smelling, tasting, and feeling complete the list of the special senses; and yet, one dictionary will tell you that we have seven, and another will enumerate twelve, senses . . .
>
> The medical examiner has not been asked to study the physical requirements of jobs. His tests for fitness have not been questioned. If he wanted to stop with feeble observations of eyesight and hearing, all very well. No one knew any more than he, on these matters. The rôle of the other senses in personal efficiency certainly is not commonly appreciated.[2]

The need of more thorough as well as more frequent and intelligent physical examinations has been stressed in a preceding chapter as an important adjunct to accident prevention, but we must not overlook the vital bearing of sense defects on the efficiency of the individual as an industrial producer. We are approaching an adequate recognition of this in the matter of eyesight and there is already considerable published information on the wide prevalence of substandard vision. The Committee on the Elimination of Waste in Industry is authority for the statement that the actual rejections because of eye trouble were 21.7% in the National Army.[3] The Life Extension Institute found as high as 53% of employes in factories and commercial houses with uncorrected, faulty vision. At the plants of William Cramp and Sons

[1] "The Mental Causes of Personal Injuries," *Proc. Nat. Safety Council*, Twelfth Annual Safety Congress, p. 1039, 1922.

[2] "Mental Causes of Accidents," p. 60.

[3] "Waste in Industry," p. 381.

Ship and Engine Building Company, 51% of the employes examined had defective vision, at Cheney Brothers 52%, at Bausch and Lomb Optical Company 50%.[1]

A more recent and complete survey has been made by the Eye Sight Conservation Council. In a group of 204,817 employes of 37 industrial and commercial establishments 55.7% were reported as having normal vision without glasses, 19.6% defective vision corrected, and 24.7% defective vision uncorrected. In the case of 12,795 employes, however, of the seven companies in the group that made thorough tests (refractions), the proportion with normal vision without glasses fell to 28.0%! Tests of 3,513 applicants for employment in the Buick Motor Company during January to April, 1924, indicated that, while only 5.5% were already wearing glasses, 48.6% had uncorrected defective vision which could be corrected by glasses.[2]

There appears to be but little information upon the effect of poor eyesight on individual production efficiency and the ability to avoid accidents. It must, of course, depend somewhat upon the nature of the individual's occupation, surroundings and relative familiarity with his work, but that there is in all cases some positive effect cannot, for a moment, be doubted. Resnick and Carris state:

> The direct effect of subnormal vision on the quantity and quality of production, on the amount of spoilage of raw materials and finished products, and on the general contentment of the worker is so evident as to need little elaboration.

They then cite the results of careful surveys made by Dr. H. S. Reynolds on Cheney Brothers on production by employes before and after corrective glasses were provided, which showed an average improvement varying from 3.3 to 11.1% for various groups. In the Whiting and Davis Company, where a large amount of fine work was required, eye examinations indicated that, while 8.3% of the employes were already supplied with satisfactory glasses, 91.6% actually needed them. Glasses were accordingly ordered and 3 months later the average daily production for the same number of employes had increased 28%![3]

[1] RESNICK and CARRIS, "Eye Hazards in Industrial Occupations," p. 132, National Committee for the Prevention of Blindness, 1924.

[2] *Bull.* 7, "Eyesight Conservation Study," pp. 81 and 84, The Eye Sight Conservation Council of America, N. Y., 1925.

[3] *Ibid.*, p. 139.

R. E. Simpson of the Engineering Bureau of the Travelers Insurance Company sums up the situation in this way:

In certain industries good vision is a specially important factor in maintaining a fair rate of production; and in some of these industries a thorough examination of the eyes of the workers, coupled with the use of correcting glasses for those found to have defects of vision, has been rewarded by a marked increase in production—in some cases as great as 25%. Good vision is essential to our safety; in fact, sight is the most important of all the senses for protection against injury. Any impairment of vision deprives a man of a corresponding amount of his natural protection, and also handicaps him in many other ways.[1]

It is conceivable that a defective sense of taste or smell might under unusual conditions contribute to an accident though it is a little difficult to understand how it could affect an individual's success as a producer. The case against defective hearing, however, is quite obvious, though largely contingent on the nature of his employment or occupation at the moment. Many workers have been killed because they failed to *hear* a warning, and many more have lost their jobs because they failed to *heed* one, though it may be presumed that the failure to heed was in some instances merely the direct result of failure to hear.

The possible consequences of defects in the more obscure senses are not so readily understood. A sense of rhythm is important in repetitive work, such as punch-press operation. "Every person has his own best rate of repetition of movement, a rhythm peculiar to himself."[2] In discussing the probable effect of this on conditions of work, Boyd Fisher observes:

It is quite likely, therefore, that there is an accident hazard in putting an operative whose sense of rhythm is too slow or too unstable, on a dangerous machine with regular beat, such as a punch press. If he gets out of time with the machine, he will put his finger under the die, and leave it there. A marine engine tender in turning the cap of an oil cup has to insert his arm in and out between the giant strokes of the piston once every revolution. Just what would happen if his sense of rhythm were deficient, I cannot say, but I have watched many times, in the expectation of seeing him insert his arm at the wrong time.

**Distraction.**—Distraction may be the result of many conditions, internal as well as external, but however it occurs, production

[1] "Defective Vision and Industrial Accidents," *Am. J. of Physiological Optics*, **5**, 1, p. 48.

[2] Myers, C. S., "Mind and Work," p. 18, G. P. Putnam's Sons, 1921.

efficiency must suffer. Distraction from external causes will be less apt to happen in a well-ordered, well-arranged factory where work goes on smoothly than in uncomfortable, crowded, unwholesome surroundings. There will be less distraction from internal causes in a plant where employes are well taken care of and are satisfied than where there is mental unrest. Little things as well as great are distracting, and often it is the constant repetition of minor annoyances rather than their magnitude that disturbs us. We recognize this in the expression, "just one thing after another."

Even poor housekeeping in the shop, consciously or subconsciously recognized, is a distraction. We know that it occasionally causes accidents, but it also has its indirect and probably continuous effect on production. It is patent that lack of orderliness makes for uncertainty and interruption, and poor housekeeping is itself but a symptom of lack of orderliness. It leads, also, in many cases to what might be termed *false congestion* and a consequent clamor for "more room." A good housecleaning, disposal of unnecessary objects, proper routing of materials, demarcation of aisles, provision of storage racks and waste bins, and similar changes have served to convince more than one foreman that there was more room in his shop than he actually needed.

Fisher cites the following interesting case:

> There was an automobile body manufacturing plant in Detroit which had so many accidents in the woodworking department that it became known as "the slaughter house." In running circular or band saws, workmen frequently made false movements and cut their hands instead of the lumber. In one particularly bad month, 27 fingers were lost. This brought matters to a crisis. The management was more or less conscientious. They faced the situation humbly and finally came to the correct conclusion that the real trouble did not so much lie with the workmen as with the fact that scheduling and plant housekeeping were both as bad as possible. Trucks of material blocked all of the aisles; finished pieces were not removed promptly, or in proper sequence; stock chasers were running all over the plant for what they needed. The workmen on piece work at one time were laboring under the double pressure of the foreman's demands and their own desire to boost their earnings. At other times they were waiting for material blocked at previous machines. A general atmosphere of physical and mental confusion prevailed. Periods of hurry and anxiety kept men distracted when their attention should have been fixed in an orderly and peaceful way upon the dangerous task in hand.

At last the company introduced an efficiency engineer who had done good work in a neighboring plant. In a very brief time he straightened out the scheduling and the material movement. There followed promptly a noticeable reduction in the accident rate. The unsavory reputation which the plant had had with its workmen was improved and the company was saved from being dropped as a bad risk by a mutual compensation insurance company.[1]

An expenditure of energy is necessary for the creation of sound of any sort. Noise is useless sound—therefore, wasted energy. It is also an obvious source of distraction.

Noise distracts attention which is thus either distributed over too wide a field, with a corresponding loss of intensity and directness, or necessitates a more mental application to the task in hand in order to overcome the distraction . . . A lowering of the physical and mental state because of fatigue, caused by noise, is one of the primary causes of accidents.[2]

Goldmark and Hopkins showed the influence of excessive noise on labor turnover and absence. The five noisiest departments of certain plants had the highest rate of absence, the next to the highest number of requests for transfers and the next to the highest actual turnover. The effect of bad air, eyestrain, night work, bad lighting and muscular strain on absence, transfers and turnover was in general less pronounced.[3]

Accidents themselves cause distraction, and distraction causes more accidents: the effect is cumulative. A fire occurs; it is an accident. A child running to the fire is distracted and is run over; it is another accident. The ambulance on its way to the scene collides with another vehicle and causes another accident because its driver is distracted by the urgency of the situation. Such a train of accidental happenings is not uncommon and has its industrial parallels in endless variety. We cannot tell the extent to which employes are distracted by an industrial accident but, if it is a particularly harrowing one, every employe in the plant may be temporarily affected and his work suffer in conse-

[1] "Mental Causes of Accidents," p. 156.

[2] "Report of Committee Investigating the Elimination of Excess Noise," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, **1**, p. 192, 1925.

[3] "Comparison of an Eight-hour Plant and a Ten-hour Plant," *Public Health Bull.* 106, U. S. Public Health Service, Washington, 1920.

quence. The following instance, which has been widely quoted, is illustrative:

In a recent case, where a man was injured by falling into the hold of a vessel, a safety engineer happened to be present and kept a record of the time loss involved which was as follows: Five men stayed with the injured person, holding his head, etc., for 27 minutes, until arrangements could be improvised for hoisting him from the hold. Seventeen men stood looking down, giving suggestions and helping prepare the hoisting apparatus. Nine men carried the injured man off the vessel—4 minutes. Five went to the hospital with him and were gone for 15 minutes. There was a total loss of time of persons other than the injured man of over 12 hours. This did not include the distraction of attention and intermittent discussion of the accident which would naturally take place among the men for the remainder of the day and even on succeeding days.

**Fear Complex.**—Distraction may be caused by fear of injury, and a sense of security should benefit production. Myers remarks:

An obviously psychological factor which helps to increase output is security against danger. In dangerous trades, the workers show a tendency to neurasthenia. This is especially marked among coal miners; of the cases of nervous breakdown occurring during the late war, a disproportionately large percentage was found among soldiers who had been miners.[1]

In the experience of the duPont Company the author has encountered nothing suggestive of neurasthenic tendencies in its workers. In plants manufacturing explosives, uniform production and low accident rates are secured through proper control and supervision of the operations and the operatives. Absolute orderliness of procedure and immaculate housekeeping are insisted upon. Reasonable standards of daily production are recognized but the requisites of cleanliness and safety are paramount.

While the possibility of a catastrophe is doubtless present at all times in the men's minds and they are alert to detect anything amiss, fear as such appears to be absent and even apprehension seems to have disappeared under continued familiarity with their work. Any attempt by the management to compel abnormal production, however, or even normal production under conditions regarded by the men as unsafe, would almost certainly

[1] "Mind and Work," p. 60.

set up a fear complex which would curtail production, if not terminate it—in other words, the crews would refuse to work under such conditions. In the manufacture of explosives, distraction, especially with fear as its basis, would be inhibitive. It should also be noted that, contrary to common belief, wages higher than normal are not commanded by explosives workers, and in the absence of such an incentive those who have a pronounced fear of explosives presumably do not seek employment in this industry.

In ordinary industrial establishments there have probably been many instances where an added sense of security has helped to increase production or performance without its being realized by either employer or employes, as well as many recognized cases of which no record was kept. In the latter respect, the following instance is rather exceptional and serves well to illustrate the point:

At the Moccasin power plant of the Hetch Hetchy project, a surge chamber 40 feet in diameter by 160 feet deep was being constructed of concrete. After the concrete had reached a height of 80 feet, it was decided to stretch a life net between the walls of the chamber to serve the double purpose of saving the life of any workmen who might fall from the top and also provide protection for the men below from falling timbers. While the net was installed solely with the idea of affording protection, it actually resulted in reducing the cost of the work, it is stated, due to the added sense of security afforded the workmen, which enabled them to speed up all operations in connection with the concrete lining, with the result that the time required for completing a 5-foot lift was reduced from 56 hours to 48 hours—an actual saving in labor cost of nearly 20%.[1]

Fear not only causes mental distraction for the moment, but, when continued, sets up worry and a train of complexes which affect not only the mind but ultimately the condition and functioning of the body. We are all familiar with extreme cases of this sort, but in the milder cases which escape our notice we may suppose that the same general effects are produced to a less degree. We may safely say that fear of an accident or worrying over our safety not only distracts us from other things but may render us even more liable to accidental injury. This state however, is to be differentiated from that of *care* or *caution,* in

[1] *California Safety News*, Industrial Accident Commission of the State of California, **9**, 2, p. 17, June, 1925.

which we are mentally alert to avoid danger. Fear is an emotion; care is a habit which, when acquired, ceases to distract.

**Physical Aspects.**—Everyone knows that he is capable of doing his best work when "fresh." This usually occurs in the morning after being refreshed by proper sleep, especially in the morning of a day when the weather is stimulating. Further, we need agreeable working conditions and good light. Dismissing the subject of general working conditions, which has already been discussed, the more important elements are age, absence of fatigue, proper ventilation and adequate illumination.

*Age.*—This subject has already received some attention in preceding chapters. The studies made by Chaney of the influence of age upon accidents[1] seem to yield but little that is suggestive in a corrective sense other than that every plant should make a critical examination of its accident frequency and severity on the basis of age groups. Chaney found somewhat lower frequency in the 30- to 39-year group than in the 20- to 29-year group, while the rate for the 40-and-over group was lower still. This he believed to be the effect of labor recruiting from younger men; in other words, experience was the controlling factor rather than actual age.

The experience of the duPont Company during 1923 to 1924 is shown in Table XV.

TABLE XV.—AGE OF INJURED IN RELATION TO INJURY FREQUENCY, E. I. DUPONT DE NEMOURS AND COMPANY, 1923 AND 11 MONTHS OF 1924

| Age group | Average names on payroll | Average number of tabulatable injuries per 12 months | Average frequency of injury per 1,000 names per year |
|---|---|---|---|
| 10 to 19 | 728 | 15.1 | 20.7 |
| 20 to 29 | 2,530 | 72.3 | 28.6 |
| 30 to 39 | 2,333 | 62.9 | 27.0 |
| 40 to 49 | 1,741 | 48.8 | 28.0 |
| 50 to 59 | 778 | 23.4 | 30.0 |
| 60 to 69 | 234 | 5.2 | 22.2 |
| 70 to 79 | 31 | 0.5 | 16.1 |
| Total | 8,375 | 22.8 | 27.2 |

[1] "Causes and Prevention of Accidents in the Iron and Steel Industry, 1910–1919," *Bull.* 298, U. S. Bur. Labor Statistics, p. 173.

These figures, of course, cover but a relatively small group of industrial employes. There is little foreign labor employed, employes under 20 are assigned to comparatively safe work and older employes are usually on light work and are retired when the personal hazard becomes too great.

Aside from injury frequency, there is good reason to assume the existence of a higher average disability per accident in employes over 60 than for younger men, due to less recuperative ability and to greater liability of injury from falls, resulting in severe fractures, especially of the lower limbs. In industrial life, however, this is probably offset by placing the older men in safer jobs, not because their accident liability has been recognized, but because they have begun to exhibit lower productive ability in their regular employment.

*Fatigue.*—There has been much written and much difference of opinion on what constitutes fatigue, its causes, its effects and especially its relation to industrial output. In *Safe Practices Pamphlet* 50 the National Safety Council names three types of fatigue:

1. Ordinary physical fatigue due to muscular exertion.
2. Mental fatigue due to use of the mind.
3. Nervous fatigue due to exhaustion of nerve force.[1]

The authors further observe:

> A certain degree of fatigue is a normal result of bodily activity and is harmless. Fatigue becomes harmful, however, if carried to the point where complete recuperation does not take place after a reasonable period of rest. Such fatigue not only lowers the efficiency of the worker, but also slowly undermines his health. Overfatigue means an accumulation of the poisons (toxins) which in a fatigued person are generated faster than they can be carried off or replaced. Such a person, therefore, is literally poisoned.

The preceding quotation furnishes a sufficiently clear statement of the case to answer our present requirements, qualified perhaps, by a caution against confusing weariness ("that tired feeling") with actual fatigue. To those who desire to go deeper into the subject we suggest reference to the work of P. S. Florence, the Gilbreths, Josephine Goldmark, H. M. Vernon and others who have specialized in it. Much of interest will be found in *Bull.* 249 of the U.S. Bureau of Labor Statistics, "Final Report of

[1] "Practical Methods for Reducing Fatigue," *Safe Practices Pamphlet* 50, National Safety Council, Chicago, 1922.

the British Health of Munition Workers' Committee," *U. S. Public Health Service Bull.* 106 ("Comparison of an Eight-hour Plant and a Ten-hour Plant"),[1] and "Mind and Work," by Charles S. Myers.[2] For the executive or engineer who desires merely a general survey of the subject from the standpoint of accident prevention, Chap. IX, "The Tired Mind," of Boyd Fisher's "Mental Causes of Accidents," is particularly recommended.

Our interest at the moment lies in the combined effect of fatigue on production and on accident causation. The relation to production is summarized by Myers as follows:

> It is, of course, to be expected that the curve of industrial output must vary considerably with the kind of work done. When the work involves merely strenuous muscular exertion we may expect a rapid and early rise in the work curve to a maximum, followed by a fairly definite fall during the morning spell, and after dinner a fair recovery followed by a progressive, well-marked fall throughout the afternoon. When, on the other hand, the work is characterized by skill and dexterity, we find a slower, more gradual rise to the maximum, followed by a less obvious fall, a less complete recovery after dinner, and a much smaller drop at the close of the afternoon. When, as in machine work, the output is largely independent of the human factor, the curve of output may be expected to reach a maximum at about the third hour of the morning spell, then to fall slightly, and during the afternoon to maintain so high a level that the output may exceed, or at least equal, the morning's output. Lastly, when, as in lathe machine work, the fact of rhythmic action is added to skilled and strenuous movement, not only will the afternoon's output remain high, but also no fall may occur in the last hour of the day; while the morning output will start at a low level and increase enormously during the first 3 hours of work, falling towards the end of the morning less than in purely muscular work, but more than in merely dexterous work.[3]

Except for the occurrence of "beginning spurts" and "end spurts," the causes of which may be complicated and obscure, the deductions of Myers seem to agree with the results of other

[1] In conjunction with this should be read National Industrial Conference Board *Special Report* 14 ("Unwarranted Conclusions Regarding the Eight-hour and Ten-hour Workday") and pp. 184-191 of *Bull.* 298 of the U. S. Bureau of Labor Statistics ("Causes and Prevention of Accidents in the Iron and Steel Industry, 1910–1919").

[2] G. P. Putnam's Sons, New York and London, 1921.

[3] *Ibid.*, p. 54.

careful studies of the subject, but the final conclusions reached by Goldmark and Hopkins in so far as they relate to the effect of fatigue on accidents and production are of particular importance to this discussion. They are as follows:

1. In the absence of fatigue, accidents vary directly with speed of production owing to increased exposure to risk.

2. The breaking up of this regular variation by fatigue is indicated by:

(*a*) Rise of accidents with fall of output.

(*b*) Disproportionate rise of accidents with rise of output, and absence of a proportionate fall of accidents with fall of output in the final hours of the day.

While the author believes that the first conclusion is unnecessarily broad as expressed in its present unqualified form,[1] the second conclusion, supported as it is by the confirming evidence of what is perhaps one of the most careful investigations of the subject yet made, is of real significance. We may interpret it to mean that the presence of fatigue tends to offset safety effort and brings about an increase of accidents disproportionate to increased output, and, during a period of declining output, fosters a bad accident rate. It can be presumed, moreover, that this effect would be accentuated by:

1. Increased pressure for output that occurs from time to time in the course of every industrial enterprise.

2. Accession of new and unskilled men.

3. Hours of labor prolonged beyond the normal (whatever that normal may be).

4. Night work, if proper rest has not been secured during the day.

5. Individually poor physique, sickness or bad health conditions in general.

To secure the minimum bad effect from fatigue, working conditions and the condition of the workers must be the optimum. Absence of fatigue should be reflected in greater output, measured both by quantity and quality, and in greater freedom from accidents of all sorts, including those causing personal injury as well as those resulting in mere damage to equipment, loss of material or interruption of work.

*Ventilation.*—Exhaust systems when installed for the purpose of dust or fume removal, in addition to preventing the breathing

[1] Compare p. 223.

of air surcharged with noxious materials (or at least reducing the amount of such materials breathed) and diminishing the fire and explosion hazard by the removal of inflammable vapors and dusts, make it easier to maintain a clean and orderly establishment. They may also aid production in other ways. The creation of dust, for example, may interfere somewhat with the working of a tool or the manipulation of the material being worked on. In other processes dust in suspension may be objectionable from the standpoint of its effect on the finished product. Somewhat similar objections may be entertained to the presence of fumes in the working atmosphere. Through corrosive action they may affect the life or maintenance of the structure or its mechanical equipment, causing more rapid depreciation or necessitating more frequent painting.

Although no satisfactorily comprehensive statement covering all such conditions can be made, it can be said that in general, better and more consistent work will be done in shops where dust and fumes are removed than where their presence is tolerated. For the sake of economy and efficiency the exhaust openings will be located as near as possible to the points of origin of the noxious materials, since this will reduce the atmospheric pollution and diminish the amount of air which must be handled by the system. Dust and fume removal by general room ventilation, either natural or artificial, is neither effective nor economical.

The exhaust hood itself may function also as a protective appliance and by its installation bring about a reduction in the insurance premium. H. G. Wiberg of the Lumber Mutual Casualty Insurance Company states:

> In the woodworking industries one-half or more of the premium paid represents the cost of accidents at the cutting heads (point of operation) of machines. Exhaust hoods on molders, matchers, stickers and surfacers covering all the cutting head, except the side actually cutting stock, constitute the major part of the guard approved by the various state rating organizations. Those hoods with a cover over the infeed rolls mean a premium reduction running from $5 to $25 per machine annually. The amount varies because the rates vary by states and because of the difference in size of plants and consequently in premium paid. The prevention of accidents resulting will mean an additional saving in the rating based on the accident record.[1]

[1] "Exhaust Systems in Woodworking Shops," *Proc. Nat. Safety Council,* Fourteenth Annual Safety Congress, **1,** p. 1126, 1925.

An interesting corollary to dust and fume removal are the systems of collection, absorption, precipitation or condensation by which the exhaust air is scavenged of its contents. These render the discharged air innocuous and in some situations, with the addition of reconditioning appliances, permit its recirculation, thus conserving a large portion of its heat. The principal object, however, is usually the recovery of the dust or vapor, and the saving effected thereby has in many cases amply repaid for the cost of installation, maintenance and operation. Notable instances of this have occurred in the white-lead industry as result of changes made primarily to remove dust as a source of poisoning. In one case, a portable motor-driven dust collector that could be moved about from place to place paid a dividend of 30% a year on the investment!

The effect of ventilation on the health of industrial workers has been the subject of close scientific scrutiny during the past decade. Recent developments have been so enlightening and so important in their bearing on the causes of fatigue and lowered efficiency that this chapter would be incomplete without a careful review of them.

The older theories that air was "polluted" or "vitiated" by the liberation of carbon dioxide exhaled from the lungs, or by other toxic volatile substances or through actual oxygen deficiency, have given way to the modern theory based on the maintenance of heat balance in the body.

> Our present conception is that beings constantly produce and give off to the atmosphere their excess of heat. This heat is carried away partly through the lungs in the expired air, but chiefly through the skin by radiation, conduction, convection and the evaporation of perspiration. An atmosphere must surround the body which is neither too hot nor too humid to insure this heat removal. In many industrial plants, an atmosphere exists which is too humid for the proper dissipation of the body heat, and the normal physiological functions of the body are interfered with.[1]

The cooling power of the air, which we call *freshness*, depends on its motion, temperature and humidity. When these fall below what is necessary for proper conditions of work, blood is

[1] McConnell, W. J., "A Study of Physiological Effects of High Temperature and Humidities," Address before the Fifteenth Conference of Industrial Physicians and Surgeons, Harrisburg, Pa., May 25, 1922.

diverted from its normal course to the cutaneous blood vessels, lowering the blood pressure, accelerating the pulse and increasing the work of the heart. Digestion and other vital processes may be deranged or impaired. At the same time there is less repair to the muscles, and the toxins of fatigue are not properly removed. This is manifested by a feeling of oppression, loss of appetite and "no energy."[1] It is essentially a fatigue and presumably reacts as such upon both production and accident occurrence.

Proper ventilation—that is, air conditioning and reasonable air movement—is acknowledged to have an important bearing on industrial efficiency and probably deserves far more attention by the industrial executive than it has heretofore received. This is particularly true of the control of humidity. Excessive humidity during summer months or in hot workrooms increases the rate of bodily exhaustion. On the other hand, the low humidity that is apt to be prevalent during winter weather, especially in working buildings where the atmosphere is subject to artificial drying or to rapid change by mechanical ventilation circulating heated air, creates a chilling atmosphere, to offset which a higher temperature must be supplied than is either economical or conducive to good work. This condition is familiar to dwellers in steam-heated apartments, but exists in many workrooms and offices as well.

For high production efficiency, proper atmospheric conditions seem to be essential.

> The influence of atmospheric conditions in factories and workshops upon the health and well-being of the occupants cannot be overlooked. The industrial worker spends the major part of his active life in an environment where heat, moisture, and in some special cases, injurious elements are constantly evolved by the process of manufacture. These conditions, as result of their effect on the health and comfort of the workers, are chiefly responsible for the quantity and quality of output and, therefore, for the general efficiency of the plant.[2]

An extensive series of laboratory investigations of the physiological effects of temperatures and humidities has been conducted

[1] ORENSTEIN, A. J., and IRELAND, H. J., "Experimental Observations upon the Relation between Atmospheric Conditions and the Production of Fatigue in Mine Laborers," *J. Ind. Hyg.*, **4**, p. 30, 1922.

[2] YAGLOGLOU, C. P. and MILLER, W. E., "Effective Temperature Applied to Industrial Ventilation Problems," *J. Am. Soc. Heating Ventilating Eng.*, **30**, p. 530, 1924.

jointly by the Research Laboratory of the American Society of Heating and Ventilating Engineers, the United States Bureau of Mines and the United States Public Health Service. Direct measurements of work performed by individuals under varying atmospheric conditions showed that at a temperature of 100°F. four times more work was performed at 30% relative humidity than at saturation, and that at 60% humidity, five times more work was performed at a temperature of 90°F. than at 120°F. A further conclusion based on test data was that at 60% relative humidity and temperatures of 110°F. and 90°F. an air movement of 350 feet per minute increased the output 40 and 50%, respectively.[1]

Actual observations that are well worth quoting were made in a silk textile mill in New England in which the production efficiency, based on theoretical maximum machine output or "yardage" increased from 59 to 79% within 3 or 4 days of the installation of air-conditioning and ventilating equipment. At the same time absences from work on account of minor illnesses, such as colds, were cut in half.

Says Leonard Hill in a contribution on "Ventilation and Human Efficiency:"

> There are two lessons to be learned by employers:
>
> 1. That attention to good ventilation and the maintenance of a high standard of cooling and evaporative power will mean less sickness, greater health, and more enjoyment of life.
>
> 2. That a cooling power adjusted to the severity of the work and the production of heat will enhance human efficiency and output.[2]

Since inadequate ventilation increases the rate of fatigue and fatigue makes the occurrence of accidents more probable, the general relation of ventilation to safety and production is more or less obvious.

*Lighting.*—In the science of artificial illumination and in knowledge of the effect of better lighting on industrial production, such great advances have been made that we are justified in discussing these subjects at some length, particularly since it is generally well recognized that inadequate or improper illumination contributes greatly to accident causation. The National Safety

[1] McConnell, W. J. and Yaglouglou, C. P., "Work Tests Conducted in Atmospheres of High Temperatures and Various Humidities in Still and Moving Air," *J. Am. Soc. Heating Ventilating Eng.*, **31**, p. 35, 1925.

[2] *Mining and Sci. Press*, **24**, p. 259, 1922.

Council mentions an analysis of 91,000 accidents which showed that about 24% were due wholly or in part to poor lighting[1] and there are available other data more or less convincing. The general acceptance of the importance of proper lighting is indicated by the fact that the departments of labor or labor commissions of 10 states have adopted regulations on factory lighting patterned, to a large extent, on the original code promulgated by the Illuminating Engineering Society, and there is now a national code on factory lighting, the work of the American Engineering Standards Committee.

The general situation has been most excellently summed up by Percy W. Cobb in the following statement:

> There are two phases to be considered with reference to the use of light, as with respect to any other of our surrounding conditions. One is its effect on our individual welfare; the other, its effect on our usefulness as productive members of the community. When we come to consider these in detail, we find that they are more or less interrelated; that, in fact, our usefulness to ourselves and our usefulness to the group within which we are units are not far from identical.
>
> The personal welfare of the individual has several aspects with reference to the lighting, not only of the actual work places, but also of the other places about the plant where he must go. The lighting of the work must be such as not to impair his health. Here, of course, his vision is of the highest interest. Further, the lighting of other parts of the works has to be considered; in relation, first, to general sanitation. Dark places are apt to be neglected in cleaning and become dirty. Good light in toilet-rooms gives an opportunity, at least, to avoid chances for infection of various sorts. And finally, but of no minor importance in the matter of the health of the individual, we must consider such intangible "mental" influences as comfort and the maintenance of good spirits generally.
>
> In a somewhat different class is the contribution that light can make to safety. Obviously, relative freedom from accidents can be achieved by the adequate lighting of corridors, stairways and the various necessary danger points in and about the works. Warning signs are of no avail without sufficient light to make them legible, which is to say nothing of the lighting of the actual situations themselves.
>
> It should not require argument to show that such conditions as favor the welfare of the individual worker, good lighting for instance, must necessarily react to the advantage of the business. The saving of the time of an experienced employe, lost through preventable accident or illness, is a most obvious case in point. Similarly, conditions which

[1] *Safe Practices Pamphlet* 22, "Shop Lighting."

make the work possible with less bodily strain, for example eyestrain, can hardly result otherwise than in increased output of work, by making unnecessary the frequent cessations or relaxations that constitute, in the aggregate, no insignificant fraction of the time that appears on the payroll.

Over and above the considerations just enumerated, we will all probably have to admit, sooner or later, that even such apparently irrelevant things as the personal comfort of the workers, and their general cheerfulness, good spirits, buoyancy or feeling of well-being—or whatever we may choose to call it—will lighten their efforts and make possible the same work with less expenditure of time and strength, or more effective work in the same time without corresponding increase in the fatigue and bodily wear and tear. The avoidance of glare, caused by an undue amount of light directly from the lighting units entering the eyes of the workers, is important for comfort as well as for efficient vision and freedom from eyestrain; and a pleasant outlook on the worker's surroundings makes for cheerfulness and willingness. It is not expected that the inside of the factory will ever come to look like the interior of a palace, but at least the avoidance of ugliness can be aimed at, even if positive beauty of environment cannot be attained. This may be done by attention to the paint on the walls and the ceilings, to the other elements of interior finish, and to the disposition of fixtures and movables which have to be in sight. Attention to the amount and distribution of the light falling upon these things follows as a matter of course, in consequence of the obvious and much neglected fact that the appearance of all things to the eyes depends entirely on the lighting of them, and is nothing at all without it. The cost of such improvements may be charged to welfare; but a subsequent comparison of output with payroll may make this unnecessary.

It will be noticed that in the foregoing discussion, fundamentals have been treated which are quite general to the subject of industrial hygiene, which are at the present time of increasing importance in factory management, and which are receiving consideration from many points of view other than that of lighting. These fundamental considerations are: the safety, health, comfort, and general mental well-being of the producing workers. It has been the especial object here to emphasize how, by proper attention to the lighting, these may be furthered and, moreover, to indicate that properly designed lighting improvements may be expected to justify themselves not only from the standpoint of humane sentiment but also from the standpoint of business.

With respect to the efficiency of the worker these may be designated as the indirect advantages of good lighting. There has been a body of evidence collected, however, to show in a striking way that good lighting has a very direct result in production.[1]

[1] "Lighting in the Industries," *J. Ind. Hyg.*, **7**, p. 185, 1925.

In recent years most important advances have been made in the science of artificial illumination, especially in the field of higher intensities. The reader is referred in particular to the *Transactions of the Illuminating Engineering Society* and to "Light and Work," by M. Luckiesh of the General Electric Company.[1] The latter author tells us not only the speed of vision increases with increase in the intensity of illumination up to the highest intensities that have yet been experimented with, but that "all laws pertaining to vision . . . show an increase in ability to see and to work with increase in illumination intensity, assuming other factors in lighting[2] to be satisfactory."

Relative to production, Luckiesh remarks:

> Tests of production under increasing intensities of illumination indicate a tendency of production to continue to increase at still higher intensities than the maximum used in the investigations. The tests on which this statement is based were made under shop conditions with intensities up to 20 foot-candles, but laboratory work on speed of vision has been performed under intensities of over 200 foot-candles.

Luckiesh expresses the belief that 700 foot-candles may be the eventual optimum for general work and the future upper limit in the neighborhood of 3,000. Comparing this with 20 foot-candles, the highest value recommended in the present American Standard, and 2 to 5 foot-candles, the intensity found in average manufacturing plants, we realize how far we still have to go before really efficient illumination is obtained. We speak of "a brightly lighted room," meaning thereby an intensity of perhaps 20 foot-candles, but outdoors at noon in summer the intensity may be 10,000 foot-candles!

Hess and Harrison[3] investigated conditions in a shop where the work consisted of inspecting material turned out by automatic screw machines. Various changes were made in the lighting system and the average number of pieces inspected was recorded. A maximum increase of 12.5% was obtained as the intensity was increased from 5 to 20 foot-candles. The fluctuations in production, moreover, followed closely the changes in

[1] D. Van Nostrand Company, 1924.

[2] Such as diffusion, distribution and brightness.

[3] Hess, D. P., and Harrison, Ward, "The Relation of Illumination to Production," *Trans. Illum. Eng. Soc.*, **18**, p. 787, 1923.

illumination intensity as indicated in Fig. 11. In other instances cited by Luckiesh in "Light and Work," factory production was increased from 10 to 30% by better lighting; in an extreme case, where the original lighting system of bare lamps on drop cords was very unsatisfactory, the improvement in one department was 100%, and in no department less than 30%.

One of the most interesting deductions to be drawn from these researches is that the cost of furnishing the extra illumination required for increased production is low in comparison to the

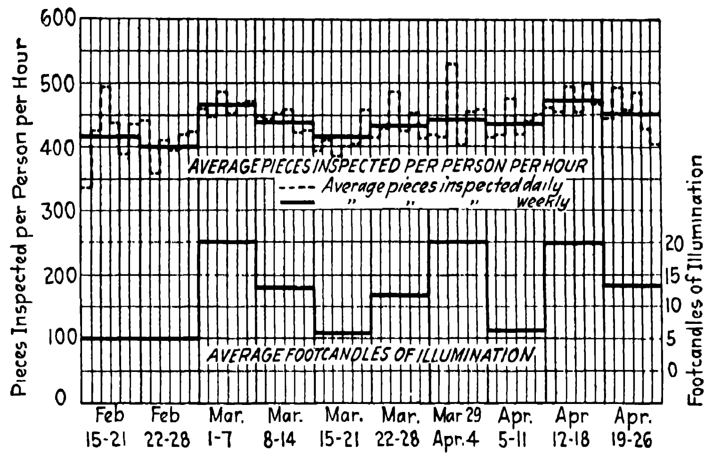


FIG. 11.—Variation of production with lighting intensity in an inspection department. (*Hess and Harrison, "The Relation of Illumination to Production," Trans. Illum Eng. Soc.*, **18**, 1923.)

value of the additional output that is secured. There seems, therefore, no valid reason why better illumination should not gradually find its way into all our more important industrial establishments and bring with it a lessening of accidents in addition to other advantages. Artificial illumination, however, is not the only subject meriting attention. If the full value of adequate illumination is to be realized, more thought should be given to natural lighting, to the cleaning of windows, including provision of facilities for window cleaning, and to interior painting and repainting.

# CHAPTER XXII

## CORRELATION OF SAFETY AND PRODUCTION EFFICIENCY

Most safety engineers and many industrial executives of plants which have done successful safety work believe that a correlation exists between safety and production efficiency. That this belief is based upon something more substantial than enthusiasm is becoming increasingly evident as time goes on and, even though convincing proofs that there is such a correlation may as yet be lacking, obviously we cannot pass lightly by a growing body of opinion which, in the light of experience, discerns in the safety movement important economic advantages over and above those accruing from accident prevention.

**Recent Views on Correlation.**—Public expressions of opinion on this matter naturally vary considerably in kind and degree. In 1920, Henry Ford stated, "Production without safety is inefficient. Accident prevention is absolutely an essential part of the industrial program." M. E. Danford of the American Rolling Mill Company asserts:

> Many managers have been deluded by the idea that safety is antagonistic to high production standards. They feel that safety and slowness, accident prevention and apathetic production are synonymous. The safety records of some of the most efficient plants of the country effectually contradict this mistaken idea.[1]

Charles R. Hook, Vice-president of the same company, explains in more detail:

> When you make a plant safe there is a psychology which begins to operate, which in turn secures for you increased production; because, instead of a man worrying about the next move he has to make—whether he is apt to get his finger too far in, or get in the way of something that is coming down—if the operation can be made more or less foolproof, he can go through with his movements without thought of

[1] "Safety Education—Fundamentals upon Which the Company Must Work," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, **1**, p. 527, 1925.

what accident might happen to him, and his production will increase. We have innumerable instances of that kind.[1]

Colonel E. M. Young, Vice-president of the Lehigh Portland Cement Company, says:

Safety work improves efficiency. Nothing has ever been introduced into cement plants which has touched the hearts and spirits of employes as has the interest of the management in their physical welfare. The work of the safety committee, the prizes for good records, the rivalry between plants for the least number of lost days bring about an *esprit de corps* which could not otherwise be developed . . . In my opinion as an executive, safety work has become as necessary and essential to the successful operation of a cement mill as a boiler house or a laboratory.[2]

R. J. Young, Manager of the Department of Safety and Relief of the Illinois Steel Company and one of the earliest and most practical workers in the safety field, writes:

It may be impossible to prove statistically that accident prevention promotes plant production, but I believe there is no doubt in the minds of those who have watched the results of this work over a period of years, that the consistent efforts of an efficient safety organization tend towards better and greater production.

It is recognized by modern executives that practical welfare work has a direct bearing on plant efficiency because it is conducive to lower labor turnover, better workmen and a feeling of loyalty and cooperation. Safety work, in its broad sense, embraces all practical welfare activities.

A safety organization does not strive alone to guard dangerous places and eliminate unsafe practices. Their big problem is one of education—the development of a feeling of personal responsibility and cooperation on the part of everyone. This is accomplished through committee meetings, mass meetings and personal contact. The management and workmen are meeting on a common ground, striving to attain a common goal and through this close association, they are bound to develop a mutual respect for the problems of each other.

Years of experience have shown that a department that is high in cost of production is also relatively high in labor turnover and accident rates. In that department is found poor quality of work, confusion and discontent. Conversely, an efficient management shows lower cost, few labor changes, fewer accidents and loyalty and cooperation on the part of the workmen.

[1] *Proc. Nat. Safety Council*, Eleventh Annual Safety Congress, p. 159, 1922.

[2] "Safety from the Executive's Standpoint," *Proc. Nat. Safety Council*, Twelfth Annual Safety Congress, p. 271, 1923.

To our mind, there is no question regarding the effect of comprehensive safety work on shop production.[1]

C. H. Almstead of Dwight P. Robinson and Company, Inc. observes:

Some general contractors have succeeded in obtaining a reduction in their experience rating in some states as high as 30 or 40%. Aside from a humanitarian standpoint, contractors are beginning to realize more and more the efficiency of construction forces working under safe conditions and, where actual comparisons were made, it was found that the builder who had adopted precautionary measures obtained more efficient results than his competitor not employing safe methods.[2]

G. A. Orth, Manager, Safety and Claim Departments of the American Car and Foundry Company, states:

Production is increased by accident prevention by conserving the energy of the workers, both in physical fitness and in time, for the purpose for which that energy is employed. It prevents the dissipation of any portion of that energy through accidental physical disability, loss of time, loss of power in replacement. It keeps constant the stream of force which has been canaled for the purpose of turning the wheels of the producing mill. Anything which stops the flow or diverts the current of that stream lessens productive power. Anything which keeps it in its steady course increases productive power. It follows, as a corollary, that a system, either of appliances or organization or of both which would eliminate accidents must be a paying system.[3]

L. P. Alford, Editor of *Management and Administration* writes:

I believe fully that a high accident rate and a low production rate go together; the quality of management that produces the one will inevitably produce the other.[4]

Other statements of a similar nature might be quoted but would add little to what has already been said. Like those preceding, they express or imply belief in the existence of an intimate connection between safety and industrial efficiency in one or other of its varied aspects but constitute no convincing proof that an

[1] Personal correspondence, Aug. 22, 1925.

[2] "Safety in Building Construction," *Annals of the Am. Academy of Political and Social Science*, **123**, 212, p. 116, 1926.

[3] "Does Accident Prevention Pay?" *Annals of the Am. Academy of Political and Social Science*, **123**, 212, p. 20, 1926.

[4] Personal correspondence, Aug. 3, 1925.

accident-free plant is necessarily an efficient plant from the production standpoint, or that every plant which produces efficiently is preeminently a safe plant in which to work.

**Production and Production Efficiency.**—Before proceeding, it will be well to clarify our conception of the meaning of the terms "production" and "production efficiency," since any conclusions that may be reached must, perforce, depend upon our understanding of them.

Production expresses, quantitatively, the output of the plant, process or machine, but when it is qualified by stating the period during which the production took place, it becomes essentially *a rate of production.* For example, 20,000 tons expresses production; 20,000 tons per month is a rate of production.

The word "efficiency" is often used somewhat loosely to denote a high degree of practical excellence, a valuable quality synonymous with effectiveness. When applied in the engineering sense its meaning is more precise, for efficiency is the ratio of output (energy or work that is got out of a machine or process) to the input (energy or work that is put into it).

The subject of production efficiency may be viewed quantitatively or qualitatively. If the latter is selected and a dollars-and-cents standard employed, production efficiency or, more properly, *production economy*, should be the ratio of the value of production to the cost of production. The use of the term "value of production," however, introduces other variables, such as sales expense and market values, which lie outside the realm of the production executive, wherefore it is customary to substitute *production* for *value of production.* The production executive, moreover, goes somewhat further and inverts the ratio, thereby giving cost per unit of production. The reader should bear in mind that cost per unit of production is essentially the reciprocal of a rough measure of production efficiency from the cost aspect.

Cost per unit of production being a qualitative rather than quantitative term, it gives no clew to the amount of product actually produced in the period under consideration. The production executive, however, needs to know the production and, as it is an important matter, it is actually counted or measured.

Production is obviously governed largely by three factors:

1. Operating time.
2. Operating efficiency.
3. Input.

By operating time is meant, not the so-called working time of the plant, but the actual time during which the plant, process or machine was functioning productively. The ratio of operating time to working time expresses time efficiency or *continuity.* The difference between working time and operating time expresses time losses or *interruptions,* accidental and otherwise.

In the preceding paragraph the term "input" has been used to express the utilization or consumption of the elements essential to the manufacturing process during the period in question. These elements are, in general:

1. Plant (structures and equipment).
2. Power.
3. Raw materials and supplies.
4. Labor.

The utilization or consumption of these elements in combination within the process is accompanied by certain unproductive losses. These may be considered to be of two general sorts: fixed losses and variable losses.

Fixed losses go on continuously. They include such matters as depreciation from age or obsolescence, mechanical transmission friction losses, leaks in pipe lines, insulation losses in electric transmission lines and loss of raw materials in storage. They are essentially those losses which cannot be properly said to vary with production but rather with working time or diurnal time.

The variable losses may be conceived as varying more or less in accordance with the rate of input or production. Typical examples may be set down opposite the essential element in the production process with which they are associated, as follows:

| Production element | Examples of variable operating losses |
|---|---|
| Plant | Wear and other continued depreciation from use |
| Power | Friction losses in pipe lines<br>Voltage drop in transmission lines<br>Belt slippage |
| Raw materials | Waste, seconds, scrap and other losses in operation and in transportation to and from the operation |
| Labor | Losses from inefficiency, usually contingent on inexperience, lack of interest, distraction and upon mental and physical deficiencies. |

In the case of each element, the sum of the fixed and variable operating losses subtracted from the input gives the output or useful portion of the expenditure. The *operating efficiency* or economy of utilization is, of course, the ratio of output to input. It may be expressed, however, in terms of losses and input by the following equation:

$$E = 1 - \frac{L_v + L_f}{P}$$

where $E$ = operating efficiency.
$L_v$ = summation of variable losses.
$L_f$ = summation of fixed losses.
$P$ = total input.

If $C$ denotes the continuity of operation, we have:

$$C = \frac{T}{T'}, \text{ or } T' = \frac{T}{C}$$

where $T$ = time of actual operation of process, and
$T'$ = working time.

Let us now express the input and losses as average rates. If $p$ is the rate of input, $l_v$ the variable loss rate and $l_f$ the fixed loss rate, we have:

$$p = \frac{P}{T} \text{ or } P = pT$$

$$l_v = \frac{L_v}{P} \text{ or } L_v = l_v P = l_v pT$$

$$l_f = \frac{L_f}{T'} \text{ or } L_f = l_f T' = \frac{l_f T}{C}$$

In this we have expressed the variable losses as a function of the input, and the fixed losses as a function of the working time.

Substituting these values in the equation for production efficiency, we obtain:

$$E = 1 - \frac{pl_v + \frac{l_f}{C}}{p} = 1 - l_v - \frac{l_f}{Cp}$$

and, if $O$ is the production output:

$$O = T'pCE = T'(pC - pCl_v - l_f)$$

If we study these equations, we discover that decreasing the continuity $C$ by increasing the number of interruptions not only decreases the time of operation, but also affects production efficiency $E$ by throwing into greater prominence the effect of the fixed losses. True, if the nature and arrangement of the

process permits it, the rate of input $p$ of power, raw materials, labor, etc. may be increased to offset this effect and keep the production up to the normal, but it will be reflected in increased costs. We are therefore justified in making the general statement that interruptions to industrial processes tend to decrease operating efficiency, decrease production and increase production costs —the latter quite aside from the expense of repairs, of restoring the service or other expenses directly entailed by the interruptions.

**General Effect of Accidents on Production and Production Efficiency.**—We are now in position to apply these deductions to the accident situation, keeping in mind the examples quoted in the two preceding chapters. If we consider accidents solely as interruptions to the continuity of the manufacturing process we must admit, in the light of what has preceded, that accident prevention, in so far as it reduces the extent of process interruption, has a tendency to increase production and production efficiency and decrease production cost. This, of course, is somewhat theoretical since, in practice, the influence of many other factors has to be considered. It seems to furnish, however, considerable justification for the belief that "a safe plant is an efficient plant."

In the foregoing, in order to simplify a somewhat complex problem, we have thought only of a simple manufacturing process. There are, however, but few simple processes in modern manufacture. Most processes involve a long series of progressive steps or stages extending from the raw materials in storage to the warehouse, shipping-room or freight car. An interruption anywhere in this chain may make itself felt all the way to both extremities. Not only is the final production proportionately decreased but the flow of product in process is interfered with, difficulties are encountered which must be adjusted and the whole operating schedule may be thrown out of joint. Even when the cause of the original interruption has been cured, full production cannot be instantly resumed. Meanwhile the fixed losses continue and must be paid for, production efficiency falls, perhaps to zero, and cost per unit of production bounds up, later to be reflected in the month's cost sheets. All this is in addition to the costs incident to the accident itself and to the repair item.

Paralleling of the manufacturing process at certain stages is characteristic of modern industry. We have, for example, batteries of boilers, rows of similar machines and multiple process units in general. Provisions of this sort do much to minimize

the probability of a general shutdown, but we cannot make the entire plant proof against it. An interruption to the power system or to the transportation system, for example, may tie up not one shop but the entire plant with proportionate damage to production and costs.

**Routine versus Emergency.**—Operating routine is the result of gradual growth from the experimental stage to the adopted procedure. It is the making of the best compromise with conflicting desires for quantity, quality, expediency, cost, safety and other objectives. It is for the moment the optimum, "the one best way" to which employes and management have become used. It is conducive to fulfilling the desideratum of "expected men in expected places" and therefore makes for accident reduction. The management has time to study its operating system, find its weak spots, and work out and apply appropriate remedies. Foremen and operatives, for their part, grow experienced in their work, learn what can be done with propriety and what not, discover how to get the most out of the equipment and how to avoid unnecessary fatigue, trouble and accidents. Maintenance men also learn what the equipment will require from time to time and how best to provide for it. Routine makes for operating and production efficiency.

When a breakdown or other operating accident occurs, routine for the moment vanishes. Management and men alike face an unexpected, if not an unusual situation. There is pressure for resumption of production. As pointed out in Chap. XX, facilities for repairs are not as good as facilities for normal operations, and repairmen themselves must accept a greater degree of hazard. It is an emergency in the full or more restricted sense, and there is no time to work out "the one best way." Conditions, too, are never precisely the same in emergencies. As result, what appears at first sight to be the quickest rather than the safest way is often selected, and the repair work is not unlikely to be interrupted by accidents of its own. Meanwhile, the production efficiency of the plant is suffering.

**Relation of the Equipment and Human Factors.**—So far we have discussed only interruptions, but we must not overlook the effect of those conditions which, though unlikely to cause actual interruptions, are persistently lowering the operating efficiency and, at the same time, creating situations more hazardous to the employe than the normal. Slipping belts and dull or improperly

set cutting tools, enlarged upon in a preceding chapter, furnish obvious examples of this. As with actual interruptions, such conditions tend to decrease production, not by temporarily stopping the output, however, but by limiting the maximum rate of output through diminished operating efficiency.[1] Operating losses increase, production costs increase and cost per unit of production increases also. Obviously, then, we should no more tolerate circumstances which render our industrial machinery inefficient than we should tolerate actual interruptions. Yet certain conditions which tend to create accidents actually do this.

Earlier in this chapter we included labor among the elements essential to production, but labor is more than this; it is *the* element which controls and makes possible the functioning of the entire plant. Without it our structures, equipment, power and raw materials cannot be utilized. It is the industrial *sine qua non.*

Labor has its fixed and variable losses in common with the other elements essential to production. In the individual employe, permanent mental or physical defects may constitute fixed losses; fatigue is a variable loss; "unwillingness to produce" and inexperience may be fixed or variable losses, the latter varying inversely with individual production. These shortcomings, defects and inhibitions may cause interruptions or inefficiencies in the utilization of labor in the manufacturing process or in the utilization of the other major essentials: plant, power and raw materials. In the first instance the relationship is simple; in the second it is complex. What has been said, then, of the equipment factor as regards its effect on production and production cost can be said with more emphasis of the human factor in industry. Those conditions of its state, individually or in mass, which make for accident occurrence must affect production and production efficiency equally and, under some circumstances, progressively. Conversely we must conclude that there is as much, if not more, reason for asserting that "safe men are efficient men" than there is for stating that "a safe plant is an efficient plant."

As maintenance must be supplied for the equipment in order to prevent more serious losses and interruptions, so must the human element be supplied with maintenance, not in the sense of subsistence (which it supplies for itself), but health maintenance, replacement when it wears out and make-up for separations

[1] In the two cases cited diminished efficiency cannot be met by feeding the machines faster.

through labor turnover. It has been seen that maintenance and repair work as applied to the plant equipment introduce conditions of lowered efficiency and increased hazards. Maintenance and repair work applied to the human element do likewise, but here again the relation is complex, for the inefficient or not-yet-efficient employe, in addition to being an inefficient producer, may bring about the necessity of *increased plant maintenance and repairs.*

**Relation of Management to Safety and Production.**—It is now possible to complete the picture by inserting management in its proper relation to the other elements. As in all things, management supplies the guiding and directing influence which controls the functioning of the industrial establishment. Because this is its true position, we may expand out aphorism by asserting that "a safe management is an efficient management" or that "a safe management makes an efficient plant." Certainly few executives will refute the statement that the condition and functioning of the equipment and human factors are within the control of the management (in so far as they are controllable at all) provided we include within the term "management" all those acting in managerial, executive or administrative capacity.

**Importance of Fundamental Research.**—The deductions made heretofore in this chapter are based to a considerable extent on hypothesis and theory, and the supporting data included in the two preceding chapters are, at the best, fragmentary and inconclusive. The subject needs the benefit of careful and fundamental research.

There are two reasons why it is of utmost importance that the industrial world should be given the substance of the relationship of safety to industrial efficiency. The first, and more important, is that industry may apply the knowledge so gained and profit thereby; the second is that the safety movement (the progress of which, though brilliant in spots, has been on the whole uncertain and slow) may go forward by virtue of a mental attitude on the part of industrial engineers and executives which has changed from the present one of sympathetic but passive acceptance to one of active prosecution. The need of such a change has been admirably expressed by L. P. Alford:

The present situation is remarkable, the outstanding features which characterize it being as follows:

1. Sustained general interest in industrial safety, accompanied by a lack of executive interest.
2. A pause in the reduction of industrial accidents, though the aggregate number in American industry is still enormous.
3. Steadily increasing costs of safety work.
4. Persistent unfavorable workmen's compensation loss ratios.

The end of this situation will mark the close of the first or superficial stage of the safety movement and will usher in the second or more fundamental stage. It will also mark a shift of responsibility for the industrial safety program from the "safety man" to the management, for this desirable second stage and its progress cannot come until the interest and active participation of executives are secured. This solution of the problem presented is therefore proof that safety is an executive responsibility . The safety movement must be made a part of the fiber and tissue of continuous management interest and responsibility. It must go forward in company with other great management movements, such as increased efficiency and elimination of waste. When this is done the real safety movement will be born. In this form it will become a part of a thoroughgoing industrial effectiveness or efficiency, both human and mechanical. Such an efficiency will yield a high operating morale in the working force, resulting in:

1. High production.
2. High degree of safety.

Once these possibilities are appreciated by industrial executives there will be aroused that interest in the safety movement which is so essential for progress, but which at the present time seems lacking.

But few records are available tending to show, on the one hand, that a safe factory has a high production record, and, on the other, that the factory with a mediocre or poor safety record has a low production record. However, many managers and industrial leaders believe that this relationship holds and that it is only necessary to secure the production and safety records from a representative group of industrial establishments to be able to present complete proof. It is sincerely to be hoped that some such investigation will be made, thereby establishing once and for all the correlation between safety and production. Once this is done, a long step will have been taken in bringing the safety movement into the great field of executive interest and responsibility.

Such a study would have value for another purpose. It would put in sharp contrast the high level of safety attainment and records in those plants which have the best managed safety programs, with the much lower but average level of a major branch of industry or of industry as a whole. It can be safely predicted that there is a wide stretch between these two records indicating the zone in which immediate improvement can be made.

This comparison would be a spur to the less effective plants by showing the improvements and savings possible to be made to meet a standard already attained, not one established on theoretical grounds. Furthermore, quantitative facts are always triumphant over opinions and rhetoric, and such a comparison would be a presentation of actual, measured results . . .

None of these comments should be construed as a reflection upon the safety work already done. Its rise and development is one of the outstanding records of American industry. But the path of future progress is to make safety an executive responsibility.[1]

NOTE BY AUTHOR: The importance of fundamental research in this field has been recognized for some time by two national organizations, the National Safety Council and the National Bureau of Casualty and Surety Underwriters. With financial support provided by the latter, a third organization, the American Engineering Council, a body whose findings will be beyond imputation of emotional or economic bias, has recently undertaken the research work.

**duPont Company Experience.**—Selecting the field immediately at hand, the author has made some personal inquiries into the matter. That efficient plant management is largely responsible for simultaneous records of good safety and good production is the opinion of many of the industrial executives of the duPont Company. In an effort to uncover some support for these statements a careful study was made of the 1917–1924 experience of a group of four similar chemical plants, which we will term Group *H*.

The group was selected because of close similarity between individual plants in equipment, processes and products. They are well-established plants under centralized control and, for the period, operated under supervision and labor conditions that were normal except for local variations caused principally by fluctuating demands for production. Common manufacturing hazards were present to the usual extent plus the inherent hazards of the process. The plants in question are widely separated, and employed about 3,500 persons in 1917 and about 1,200 in 1924. Three of the plants are of somewhat the same size, but the fourth is larger and manufactures a few products which the others do not.

During 1917–1918 the two largest plants were materially affected by war-time demands and their normal employment was

[1] "Real Safety Movement to Come," *Management and Administration*, **10**, p. 61, 1925.

greatly exceeded, this being followed in 1919–1921 by resumption of peace-time conditions in all four plants accompanied by pressure for strict economy and reduction of force, resulting in selective discharge. The period 1922–1924 was characterized by increased production and some increase in employment.

During the entire period all plants of the group were exceedingly active in accident prevention and gradually set up effective safety organizations consisting of central and departmental committees, with service supervisors having accident prevention

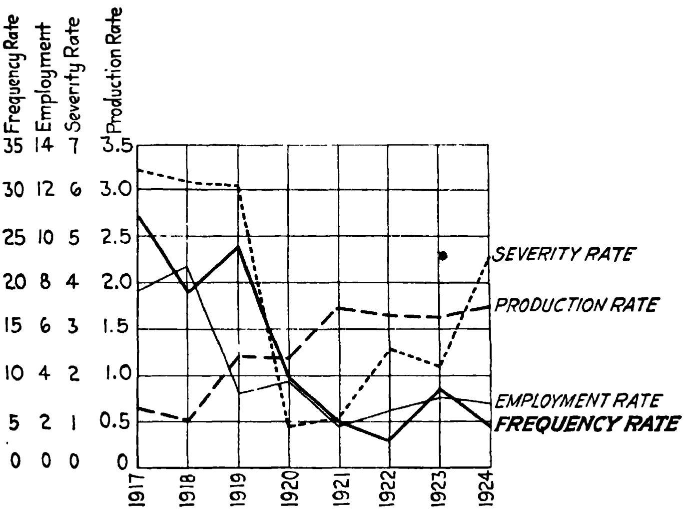


FIG. 12.—Injury, employment and production rates—Group *H* plants. (*E. I. duPont de Nemours & Company.*)

as their most important duty. Dating from an injury in April, 1920, one of these plants, with an average of 180 payroll employes, commenced a period which later culminated in a no-accident record of over 2 years. This led to a safety competition among all plants of the group, commenced April, 1921, and extending through 1922. This was followed by a no-accident contest against a "bogey" in which all plants of the duPont Company competed for prizes. These plants also held "celebrations" for 1- or 2-year intraplant department no-accident records—usually a dinner or picnic.

Figure 12 shows for Group *H*:

1. Employment in millions of payroll hours per year.

2. Production rate as "production units per 1,000,000 payroll hours."

3. Frequency rate as number of tabulatable injuries per 1,000,000 payroll hours.

4. Severity rate as days lost per 1,000 payroll hours, weighted for permanent disability or death.

What is of immediate interest is the correlation between the frequency rate and production rate curves. The latter rate is an approximate measure of operating efficiency. It will be seen that, in general, as the injury frequency rate falls, the production rate rises. In the period 1918 to 1921, production efficiency has tripled, injury frequency has been reduced to less than one-fourth of its earlier value and severity rate to one-sixth. This in itself constitutes a remarkable record. While the frequency rate fluctuated somewhat during the 3 years which followed, the production rate was held at its high level. Severity, on the other hand, showed a marked increase due to the occurrence of several severe injuries traceable principally to the inherent hazards of the business.

It is not possible, of course, to state with certainty the exact reasons for the reciprocal variation in the frequency rate and production rate curves or to what extent the safety work did actually promote a higher degree of production efficiency. Selective discharge undoubtedly had some effect. It may be said, however, that the executive head of the division operating these plants believed that at least one-half the increase in production efficiency was attributable to safety work.

Whatever factors were responsible for the profound changes which took place in the years 1918 to 1921, it should be noted that they had decidedly more effect upon injury frequency than upon the production rate. Also, the curves of the individual plants, which are not reproduced here, showed that the same reciprocal relationship between the production rate and frequency rate curves was rather consistently maintained.

## CHAPTER XXIII

## SAFETY AND HUMAN RELATIONS

In the chapters immediately preceding, when discussing the human factor in industry, we viewed it from the aspect of its *capacity* to produce; we considered the effect of accidents upon this capacity and the effect of operating conditions jointly upon capacity and upon accidents. There is, however, another element in the industrial situation, appertaining to its human but not to its mechanical side, which is of fundamental importance in its relationship not alone to safety and production efficiency, but to the preservation of satisfactory industrial relations and even to the integrity of our whole industrial structure. This is the volitional element: *willingness* to produce and its corollary, willingness to prevent accidents.

**Labor Unrest.**—P. Sargent Florence in his recent book, "Economics of Fatigue and Unrest,"[1] separates the human factor in production into two elements: the degree of willingness to produce and the degree of capacity to produce. Where the latter is variable under conditions of production, he conceives it to include a capacity which tends to increase with increased production and a capacity which tends to decrease with increased production. He points out that the three elements are more familiar to us in their negative aspects: (*a*) labor unrest, using this term in its broadest sense to denote all elements in opposition to willingness to produce; (*b*) inexperience and lack of experience, elements in opposition to capacity to produce which decrease as production continues; and (*c*) industrial fatigue, an element in opposition to capacity to produce which, when daily output is forced beyond a certain point, increases as production increases.

Within these three elements the reader will discern the larger antagonists of safety: unwillingness to undertake accident prevention; inexperience and ineptitude (as exemplified in the new man and in the misplaced man); and fatigue with its host of

[1] Henry Holt & Company, 1924.

physiological and psychological concomitants. Inexperience and fatigue have already received our attention and it is only with unwillingness and labor unrest that we are now concerned.

Labor unrest is the most threatening and the most potentially harmful of the industrial disorders. Its effect on the individual employe may not, as such, be a matter of great importance, but labor unrest in the mass, fed by ignorance, indifference, restlessness, dissatisfaction and agitation produces at one end of the scale slacking, absenteeism, malingering and turnover and, at the other extremity, strikes, disorder and social revolution. If the industrial accident prevention movement does anything to allay labor unrest and promote labor willingness, it is indeed a boon to the industrial world.

**Antipathy and Apathy to Safety.**—Unwillingness springs from two roots—apathy and antipathy. Unwillingness from apathy may be a serious obstacle, slow to overcome, but not in essence dangerous; unwillingness from antipathy is dangerous and, when it gives rise to opposition, is potentially destructive. Apathy to accident prevention is widespread and, to some extent, seems to pervade all classes of society. Antipathy to safety, while it does not appear to be encountered as a mass reaction, does make its appearance among scattered individuals. Obviously its causes and those of the more widely spread and less dangerous apathy are deserving of our consideration.

Antipathy in the individual may arise from a wide variety of causes, all of them usually of a personal nature. They include ignorance of the true purpose of the movement, misinterpretation of the employer's motives, some unfortunate prior experience encountered while supposedly following "Safety First" principles, fatalism and mental bias of one sort or another. Such antipathy may be real, fancied or merely a mental subterfuge and, as such, appear as a verbal excuse for action or inaction which would otherwise be considered reprehensible.

Among the latter cases one of the commonest is the statement that the safety effort interferes with production. This explanation is not infrequently offered by employes as an excuse for not using some safety device. Sometimes the statement is one of fact, for some safety devices, so-called, do interfere with production, but oftener it is a mere pretext for failing to do something to which the man himself is opposed. These constitute individual cases and each must be handled on its merits.

As regards general attitude toward the safety movement one does encounter occasionally a "hard boiled" foreman or construction superintendent who asserts that he does not believe in safety. Usually such men have never made an honest trial of it and their attitude is based on ignorance, fallacy or prejudice. The author has yet to meet a man, who, irrespective of his position in the industrial world, having been induced to give safety a fair, conscientious trial, recommended that it be abandoned because it was impracticable or interfered with other work. This, in itself, is merely generalization, but behind it perhaps lies the great truth that real safety can never interfere with, but must always promote, industrial efficiency.

Why, then, any opposition or even apathy to the safety movement? Why not immediate and universal acceptance? Why, also, in the case of so many individuals acceptance without consistent practice? An answer to these troublesome questions may be found in the following remarks of Albert W. Whitney, an acknowledged authority on safety education and able leader in thought on accident prevention:

> The organized safety movement was an outgrowth of the awakening of the public conscience some 15 years ago to the appalling loss of life and limb that was going on in industry . . . It was characteristic of this stage that the development should have centered about the slogan "Safety First," a sentiment which, if it is taken literally and seriously, means that safety is to be counted as the prime desideratum in life . . . The fact is, of course, that safety is not the prime object in life. Exactly the contrary is true. The most important thing in the world is adventure, and by adventure I mean a fresh, first-hand experience of life. All that is worth while in life—love, friendship, loyalty, knowledge, art, religion—are adventures in which the human spirit goes out to experience the realities of life; if these experiences lack the element of adventure it can only mean that life is not being lived in the keen way that makes it most worth while; it can only mean that life is deficient in the finest spiritual values.
>
> Evolutionary development has been along this line. It is the daring, vital, vigorous, high-souled man and woman with the courage to face and experience the world that have survived and left dependents. Our blood is full of the urge of it and it is unlikely that civilization will be able to divert the stream of life into tamer and more ignoble channels. But there is danger in living life in this way! Of course there is danger. Danger is woven into the very warp and woof of life. Danger cannot be taken out of life without leaving life flat and uninteresting . . .

How is the safety movement to be harmonized with a life of adventure? Have we two opposing concepts, the adventurous life, on the one hand, and the safe life, on the other?

That all depends upon what we mean by safety. If by safety we mean safety first in the literal sense, then good-bye to adventure. But is that the real meaning of safety, is that its deep, inner meaning? . . .

A ray of light falls on the situation when we realize that the word "safe" is incomplete by itself and must be used with a preposition. The obvious preposition is "from." But that does not help matters, for to be safe from something is still negative, it is an avoidance, an inhibition. But there is another preposition that can be used equally well, namely, "for." And here the difficulty begins to disappear for "safety for" is distinctly positive. "Safety from" leaves a vacancy, but this vacancy is filled by "safety for" . . Safety, then, instead of being merely inhibitory is in reality substitutional. It throws something out but it puts something else in its place . . . What do you choose to have thrown out of your life and what do you choose to have put in its place? As for me, I choose adventure. I choose to have the bad adventure thrown out and the good adventure brought in, and because I believe that adventure is in truth the deep, significant value in life, by that token I believe that we have here the real meaning of safety.

Take an example: You teach a boy to play football safely, or to sail a boat safely or to use a gun safely. In each case you are showing him how he can have a good adventure instead of a bad one. Instead of the bad adventure of breaking his collar bone, he can have the good adventure of carrying the ball across the goal line; instead of the bad adventure of tipping his boat over and either ending his adventure entirely by drowning, or temporarily by a stupid wait for help, he can have the good adventure of sailing on to a thrilling finish; instead of ending his hunting adventure with a bullet through his leg he can have the better adventure of the chase.

This is a very different safety from the safety of Safety First. Instead of impoverishing life it does just the opposite, it makes life richer and more adventurous .

Safety, then, is leagued together in the noble company of recreation, art, love, religion and all the other good forces of life in the work of increasing the depth and breadth and quality of life. It recognizes that there are good values and poor values in life; it gives us the chance to discriminate and select those values that we most prefer. If you are not safe then you cannot select. You must take what chance and carelessness have waiting for you in the form of an accident.[1]

[1] "Why Safety and Recreation Belong Together," Address before Eleventh Annual Congress of the Playground and Recreation Association of America, Atlantic City, Oct. 17, 1924.

Whitney's concept is, then, that safety in its constructive, positive application is a broadening, vitalizing force in life, but in its narrow, negative application devitalizes by inhibiting life's experiences. We are already somewhat acquainted with it in the latter form, for it is the "don't do this and don't do that" of our childhood. Modern parents are apprehensive of its effect on children, for out of it the "fear complex" may be built up, and it is not to be doubted that, incessantly and unintelligently applied, it does make for cowardice rather than high spirit.

But what is the mental attitude of the average adult? Knowing little if anything of the safety movement, he probably resents its intrusion as guardian over his behavior because he feels that it circumscribes and hampers his actions and desires. "Be careful" to him is synonymous with "wait," "look before you leap" and similar admonitions suggesting a slowing-up, inhibitory process. The existence of a positive, constructive aspect of safety is to him unknown. He does not realize that safety is a point of view, a mental attitude, and that after a little practice the exercise of reasonable caution in recurrent situations will cease to be an effort and become an intuitive habit—as it has already become in many of his daily actions. He is also misled by the occurrence of exceptional situations in which caution involving delay is demanded of him, but only as a temporary expedient pending changes that will later remove the hazard and render future caution almost unnecessary. Furthermore, he perhaps shares in the growing resentment against overregulation that is widespread in our country today, is responsive to the trend toward individualism and looks upon the safety movement as merely another effort at obnoxious regulation, another step in the human leveling process.

These, perhaps, are among the real causes of individual opposition today. They do not portray mass reaction so much as individual reaction. They are born of lack of knowledge of what the safety movement really is and what it is attempting to effect. That the individual opposition which springs from them yields eventually to education and experience has been already demonstrated in the industrial field. If it were not so, industrial no-accident records would be a sheer impossibility. As a matter of fact, those who have followed closely the progress of the safety movement feel that individual opposition among workmen is rapidly melting before the constantly recurring demonstrations presented to them that "safety pays."

The apathy of some industrial executives is a far more serious affair than the apathy of individual payroll men, since it negatives the honest efforts of those employes who are sympathetic. Resistance from some executives is unspeakably obstinate if they are entrenched in prejudice and self-sufficiency and no outside agency, moral or political, can *force* them into honest, whole-hearted safety work, no matter how far they may be induced to go in setting up an outward semblance of it. Such men must be left to themselves to learn the lesson that accident prevention, instead of creating interference, pays dividends in lower accident costs, increased production efficiency, more harmonious industrial relations and a clearer conscience.

**Safety and Industrial Relations.**—The progress that has been already made in industrial accident prevention has obviously been accomplished in spite of mass apathy and such individual antipathy as existed. What has the safety movement done toward improving human relations in the industrial field? Because statistical evidence is lacking, we must seek the answer in general statements and deductions, even though they cannot prove our case.

From the very beginning of the safety movement, the interest of efficient industrial management has had expression in the organization of its employes for safety. In many cases this was the first step toward new and more harmonious labor relations. It has often been said, and probably with truth, that safety committee meetings furnish the first instance in the history of industry of non-partisan and unselfish cooperation between employer and employe. According to S. J. Williams of the National Safety Council, safety is serving as a stepping stone toward industrial democracy and the peaceful solution of the labor relations problem. He says:

> The backbone of the modern safety method is safety organization and education which, of course, simply means impressing on the mind of everyone concerned that accidents can only be avoided through the cooperation of the management and the workmen, and that through this cooperation both parties are benefited. In a plant where the management and the employes are working together to prevent accidents, they understand each other better and there is less likelihood of labor unrest. Employers who truly understand the spirit of the safety movement are, in general, the first to adopt other measures to protect the welfare of their employes and to gain and keep their good-

will. The actual machinery of the safety organization will lend itself to expansion along this line. The shop safety committee may easily become a committee for the consideration of grievances and of working conditions generally. In other words, while the rapid growth of the safety movement has been largely due to motives of efficiency and economy, its fundamental motive is idealistic and humanitarian. The same motive and the same methods which have been successful in preventing accidents are successful in improving every other phase of the relations between employer and employe, on a basis of cooperation and mutual good-will.[1]

In an inspiring address before a meeting in New York of the four founder engineering societies and the American Society of Safety Engineers-Engineering Section of the National Safety Council, W. C. Dickerman, Vice-president of the American Car and Foundry Company, stated:

The industrial manager is conscious of benefits of accident prevention work other than those reflected on his cost sheets. After the physical conditions in the plant have been safeguarded and the older employes have acquired the safety thought, everyone can "feel" a difference in attitudes and points of view. Safety work, to be successful, requires that employer and employe discuss the situation frankly with each other, and so pave the way for a better understanding of all mutual problems. Both capital and labor become more than mere acquaintances. The employer realizes an obligation to promote better human relations along with better physical conditions. The employe is more willing to contribute the best that is in him because of the interest shown by the management.

Because the majority of accidents result from causes entirely within the control of the employe, safety work develops in him a pride and a loyalty which cannot be valued. Strengthening the morale of the individual and of the group will in time lead also to increases in quality, in production, and in efficiency. These can be measured if past records are complete and available, but in the majority of instances only an estimate can be given. The evidence of these accomplishments is as emphatic as actual figures representing other things, making a total that any member of the organization may be well proud of.[2]

Another industrial executive, Judson G. Rosebush, President of the Patten Paper Company, expresses the following opinion:

[1] "Memorandum on History, Growth and Scope of the Industrial Safety Movement" (unpublished).

[2] "The Broader Economics of Safety," *Nat. Safety News*, **13**, 1, p. 7, 1926.

Safety affords a steady and constant point of contact between the office and the industrial working men at a point where the working men's interests are paramount. While other evidences of the friendly attitude of the office towards the mill may be more or less spasmodic and intermittent, the matter of safety calls for constant, uninterrupted interest between the employer and the employe. Moreover, out of a safety committee may come innumerable chances for mutual understanding in other directions.

Conversely, and this I think is a very important point, a sound safety policy cannot be created in an atmosphere of suspicion, ill-will and misunderstanding between the office and the plant. Such an atmosphere is uncongenial to the safety movement, for it thrives only where there is a disposition to deal fairly, uprightly and squarely with each other all along the line. In other words, the safety movement can neither stand as the complete expression of good-will between the office and the mill, nor can it stand as the sole expression of good-will. It can only originate, develop and thrive as part of an all-around policy of right relationships between employer and employe.[1]

Still another industrial executive, Arthur T. Morey, General manager of the Commonwealth Steel Company and a past president of the National Safety Council, has expressed himself in no uncertain terms:

I have a mighty tribute to pay to the safety movement. It is one of the greatest occurrences that has happened in American history—for the reason that it was the beginning of a necessary better day—a closer understanding and relationship between the worker and the employer. Managements and men met on a basis that they had never met before since modern business was organized. They met with a mutual interest and clasped hands on a recovered personal relationship that may have meant the salvation of this country from possible conditions we do not like to contemplate. We see conditions in Russia and England that do not look satisfactory and we ponder about the future. As long as the men of America can meet as men and work out their problems together as the safety movement has taught them, and keep the personal contact with mutual understanding as the basis of citizenship and justice, all will be well.

The safety movement was the entering wedge for the present better industrial relations situation in this country. From the spirit of the safety movement, the benefit associations, shop representation plans, *et cetera*, were developed. Some men may not agree that the safety movement plays such an important rôle, but on looking backward, I

[1] "A Tentative Philosophy of Safety," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, **1**, p. 729, 1925.

think every student will see that it was most opportune that a better relationship was worked out in America about the time that it did develop, and there can be no question but that the safety idea, developing mutual interest and cooperations, occurred about that time as one of the first openings toward better relationships.[1]

Other opinions of a similar nature might be quoted at length since many engineers and executives have independently recognized and emphasized the value of safety work in promoting closer and better industrial relations. Industrial harmony is, after all, but a form of industrial efficiency, and individual or class friction as inevitably accelerates depreciation, exacts repairs and makes for destructive interruption of the industrial process as does mechanical friction. No figures exist to prove this, but it is so obvious that proof seems hardly necessary.

**Spiritual Aspect.**—The modern doctrine of enlightened industrial relations has been set forth in the following statement by a representative of one of the largest employers of labor and a past president of the National Safety Council:

The human element in industry is the factor of greatest importance. Capital cannot exist without labor and labor without capital is helpless. The development of each is dependent upon the cooperation of the other. Confidence and good-will are the foundation of every successful enterprise, and these can be created only by securing a point of contact between employer and employe. They must seek to understand each other's problems, respect each other's opinions, and maintain that unity of purpose and effort upon which the very existence of the community which they constitute and the whole future of democratic civilization depend.

But there is something more on the employer's side in this whole idea of a better and happier industrial relation than successful production, than even the safeguarding of our form of government, with all its cherished institutions. There is, I believe, something in it beyond and above any material consideration, however great or necessary that may be. Power and strength bring opportunity, and opportunity brings an added obligation that neither seeks nor expects any reward—the obligation of altruistic purpose and altruistic endeavor, an obligation unselfishly to do what good we can, each in his own time and place and way.[2]

[1] "The Steel Worker and His Characteristics," *Proc. Nat. Safety Council*, Fourteenth Annual Safety Congress, **1**, p. 534, 1925.

[2] Young, Arthur H., "The Obligations of Employers and Workers in Successful Production," Address before Twelfth Annual Convention, Chamber of Commerce of the U. S., May 6, 1924.

How is this spiritual obligation, so admirably expressed by Young, to be met, and in what way does the safety movement enable the industrial executive to meet it? Dickerman tells us:

A human life is the gift of Almighty God and as such should be treasured and preserved. It is upon this bed-rock that the safety movement has built its admirably effective structure. The whole world has responded to the inspiration and is moving forward with hope and confidence . . .

Accident prevention does pay big dividends, but these dividends are merely a by-product of this great movement. None of us would be content to work for the cash value alone of safety. No movement could spread and overlap national boundaries as safety has done if it depended alone on its dollar value. No!—the vitality of the movement rests in the desire of man to help his neighbor, in an appreciation of the physical risks of industry, and the heartfelt wish to protect those who serve in its ranks from a crippled life, an eternity of suffering or sudden death. We desire to shield, to preserve, to sanctify the great gift that God alone can give.[1]

"When thus conceived and thus executed, organized safety," declares Rosebush, "as a preacher has eloquently said, does 'more to bind employers and employes together in the bonds of brotherhood, than any other movement since the Galilean Carpenter proclaimed the brotherhood of man.'"

The safety movement today is the most significant expression of the Christian religion which exists in our economic life. The Master came into the world primarily to save life for deeper and richer experiences. Fundamentally, all over America today are thousands of men in industry who are attempting to carry out in their own business this philosophy of life through this very safety movement. While we cannot, of course, measure the extent to which the inspiration for this new comment has come from the clerical leadership of our churches in America, it is, none the less, a fact that the immediate inspiration, the immediate contact, and the immediate administration of this new evaluation of human life has come out of the heart of modern capitalism itself.

In other words, at the very time when many good men are criticizing modern capitalism as being out of harmony with the essentials of the Christian religion, there is being made by capitalism itself, a tremendous drive to emphasize, not production, not efficiency, not profits, but the essential worthwhileness, the essential priority of human values.[2]

[1] *Loc. cit.*
[2] *Loc. cit.*, pp. 729–730.

**Justification of Industrial Safety Work.**—In the first chapter of this book the author brushed hurriedly past the matter of emotional justification of the industrial safety movement and sought to prove its worth on economic grounds alone. It is fitting, however, that we should now review the entire field, setting down not only the points that experience seems to have demonstrated conclusively, but also the deductions that may be drawn with some assurance from the general expressions made by executives who have had first-hand contact with organized accident prevention and whose statements should carry weight. What we seem to uncover is this:

1. Industrial safety work, properly formulated and applied, especially through the channels of industrial organization, and consistently maintained, inculcates a new attitude of mind toward accidents. This new attitude, governing the conduct of employer and employes, leads to real accident prevention. It not only does this without interfering with the work of production, but appears to promote higher operating efficiency, increased yields and lower production costs. Thus, it justifies itself on economic grounds, yielding dividends on the investment which are in many cases remarkable.

2. Industrial safety work is not only well received by the employe but constitutes a powerful agency for promoting better human relations and fostering contentment and good-will throughout the industrial establishment. It satisfies a moral obligation that is implied in the relationship of employer to employe. It makes for better working conditions, less labor unrest and tends to mitigate some of the evils of labor turnover. Furthermore, the organization of the establishment for safety opens up channels through which other controversial matters may be disposed of and other welfare projects advanced. Industrial safety work is therefore justified on moral grounds.

3. Since it decreases unnecessary, untimely and often painful death, mutilation, human suffering and loss, and all the burdens of mankind that have their origin in the accidental injury of industrial workers, industrial safety work is justified on humanitarian grounds.

4. Because the impulse to save human life is deep-rooted in fundamental race instincts—not in the more animal instinct of self-preservation, which is essentially selfish, but rather in the instinct of self-sacrifice or heroism, which is essentially altruistic—accident prevention satisfies a human desire, an emotional urge, a spiritual prompting. Outwardly, it is emergency life-saving reduced to a practical basis and shorn of the unpleasant consequences of heroism; inwardly, it is a practical application of Christian teaching to modern industrial life. It is therefore justified on emotional and spiritual grounds.

If these claims are true, as the author believes to be the case, we have in industrial safety a truly wonderful movement of incalculable value and irresistible power. Its foundation on human instinct and spiritual values, its utter repudiation of selfish motives, its addition of a high emotional purpose to the force of practical expediency will enable it to carry forward to unimagined limits. Not only are its basic principles applicable to the prevention of accidents in fields other than the industrial, but it is teaching us a practical means by which new points of view may be inculcated in the mind of the adult mass, a principle in adult education through organization, which we can employ without interfering with other work in hand—indeed, with actual promotion of other work in hand. It is also teaching us a means for bringing about closer and more human relations with our fellow men.

But the industrial safety movement is also casting a new light on life's accidental tragedies which reveals aspects that are startling in the extreme. It is demonstrating for the benefit of those who care to give heed that certain so-called "accidents" that have been heretofore considered unavoidable can be really avoided, not singly but in mass, and without any serious interference with other ideals and pursuits. This is the lesson of the prolonged no-accident records during which accidental injuries of both the avoidable and the so-called "unavoidable" classes entirely cease. Here, indeed, is food for thought and it seems not untimely to inquire what other tragic and "unavoidable" events in life, which add their quota to the sum of human hardships, misery and loss, are in the mass avoidable when the way has been uncovered. Have we a case, for example, against sickness, or labor unrest, or even poverty?

**Conclusion.**—The world of the white races is today reaching out for new scientific, artistic, economic, political, moral, ethical and religious footholds as never before. Old standards are being critically surveyed, new values assayed, and the entire human establishment, presumably as an aftermath of the World War, appears to be feverishly engaged in house cleaning and stocktaking of its faiths and creeds. It is the age of readjustment.

Doubtless at some future time the house will be set in order and we shall be glad that the work was done. In the interim we see only the endless clouds of dust, the constant sweeping of rubbish into the gutters, the recovery of articles long for-

gotten, the rearrangement of the mental furniture and ornaments revealing combinations that are new and aspects that are strange. Our ears are deafened by the clamor of those urging a return to the old order, those espousing a new, those who would regulate the world and those who resist regulation and, above all, the lament of the unfortunates who, siding with no extremists, object to being forced out on their porches by the pother set up inside and desire only to be let alone.

Economists tell us that half our man-power is wasted; that we are "a race of weevils consuming its substance without the intelligence for the future which animates a colony of bees." Psychologists tell us that 70% of our manhood has the mental development of age 14. An eminent biologist avers that of mass psychology "the expert politician knows ten times as much as the best psychologist." An eminent moralist informs us that, notwithstanding the apparent changes in morality that have been going on for ages, we have had no morality to change!

In all this welter of thought and its expression it is indeed difficult to distinguish the presence of basic needs. There is no unanimity on the nature of our disorder. If there is any concordance among the more deliberate thinkers, it seems to be in sensing a lack of spiritual motivation, a source of emotional enthusiasm, a Pillar of Fire to lead us out of our difficulties, out of the morass of destructive dissection and criticism, into a land of greater promise, of more leisure for adventure, expression, creation and good-will, of more *living* rather than *existing*. We sorely need something with high emotional and spiritual qualities which will motivate the practical adaptation of life to science and thought, that will permit humanity really to reap the benefit of its explorations.

From what precinct of human life this new source of spiritual energy will emerge, no man can say. There is, perhaps, as much chance of it being discovered in the field of industrial experience as elsewhere, since industry is vitally concerned with the practical adaptation of life to science and thought. Will any of the lessons taught by the industrial safety movement help us to discover it? It may be, but only time can furnish a satisfactory answer.

# APPENDIX

# APPENDIX A

DU PONT

P. I. No.

## INJURY REPORT

Works | Date of Injury | Day of Week | Hour, A M / P M
Name and No of Bldg in or Near Which Accident Occurred | Indoor / Outdoor
Name of Injured and Empl No | Dept where Employed
Occupation | Rate per Hour | Working Hours per Week
Length of Service, This Plant | Company | Nationality or Race | Age
Understands English? | Speaks English? | Reads English?

Nature of Injury
What First Aid? | Date | Hour, A M. / P M
Where Given? | By Whom? | Est Loss of Time?
Where Sent (Hospital, Surgeon, Home, etc)? | Means of Conveyance?

**Description of Accident** (Give full details, being particular to describe conditions preceding the accident, work in progress, stage of process, actual acts of injured and fellow workmen, etc, so that a clear picture of the accident is given—use another sheet of paper if necessary)

Does statement of injured and witnesses agree with above? | If not state wherein they differ

In fatal cases attach a statement giving names and relationship of dependents and in all serious cases obtain and attach signed statements of witnesses

FRONT

# APPENDIX A.—(*Continued*)

**Conditions at Time of Accident (Cross out those not applying) — Normal Operation — Minor Repairs — Major Repairs — Adjustments Oiling — Experimental — Breakdown — Serious Emergency — Space Insufficient — Obstructions — Artificial Illumination — Poor Light — Excessive Heat — Cold — Fumes — Steam — Slippery — Poor Housekeeping — Other**

**Additional Explanation**

---

**What guards, safety devices etc., were applicable?**

**Were these provided?** **In use?** **In good condition?**

**Du Pont standard?** **Effective?**

**If they did not function properly, explain why**

---

**How long was injured familiar with the process and local conditions where accident occurred?**

**How long was injured experienced in work he was doing?**

**Where was person in direct charge of this work?**

**What specific instructions had he given?**

**If fellow workman contributed to accident give his experience in this class of work**

**If injured or fellow employee thru failure to obey rules or instructions contributed to accident, state clearly how**

**If lack of experience or skill of injured or fellow employee contributed to accident, state clearly how**

**If defective construction or equipment or use of improper appliances contributed to accident, state clearly how**

**Could closer supervision or more detailed instructions have prevented this accident?** **How?**

**From your investigation of conditions, assign the responsibility (see "How") and give reasons for the assignment**

---

**What changes have been recommended to prevent recurrence?**

**What action on these?**

---

**Give date compensation begins** **At what weekly rate?**

**This accident was investigated by**

______________________ **Mgr**

REVERSE

# APPENDIX B

Form 20171—5M 9-25

## INJURY CARD

P I No | Works | Date | Day | Hour A M / P M

Cause | Responsibility

Name | Age

Occupation | Working Hrs per wk | Rate

Dept where Employed | Service: Plant / Company

Nationality or Race | Experience in work

Understands English | Speaks English | Reads English

Bldg or Place | How long familiar with | Indoor, Outdoor

Working Conditions

Safety Devices

| | Tab. | Non Tab. |
|---|---|---|
| Temp | | |
| Perm Part | | |
| Perm Total | | |
| Fatal | | |

Nature of Injury

First Aid & Disposition

By Whom?

Est Lost Time | Actual Lost Time | Time Allowance

Perm Dis

Wages $

Perm Dis

Medical

Miscl

Total Cost

STANDARD INDEX CARD CO 81470C

FRONT

### Description of Accident & Remarks

### Recommendations

REVERSE

# APPENDIX C

DU PONT

## SURGEON'S PRELIMINARY REPORT

_______________191

WORKS

PERSONAL INJURY NO.

Name?

Residence?

Date of Injury

A M
P M

Bld'g or place where injured

Date, hour and where examination was made

Describe injuries

What treatment given

Witnesses of operation, if any

Disposition of case

Prognosis, with probable time from duty

Case was placed under my care by

If previously injured, give date and nature of injuries

Did your examination of injured man indicate any physical weakness that might have any bearing on his injury or present condition?

(Signed)

This report to be sent to Works Superintendent as promptly as possible Works to forward necessary copies to Wilmington on date received

APPENDIX D

DU PONT

## SURGEON'S PROGRESS REPORT

______________ 19

WORKS

PERSONAL INJURY NO

NAME

PROGRESS OF CASE

ESTIMATED LENGTH OF
DISABILITY FROM DATE
OF THIS REPORT

______________
(SIGNED)

(When a case extends over ten days, these Progress Reports should be forwarded to Works Superintendent by Surgeons at intervals of not more than two weeks.) The works should copy report in triplicate, sending original and two copies to Wilmington on date received, and retaining one copy for file.

# APPENDIX E

DU PONT

## FINAL DISABILITY REPORT

CONCLUDING REPORT OF
ATTENDING PHYSICIAN

Date

Works

Personal Injury No.

Name of Injured

Discharged From My Care

Condition When Discharged

Did Permanent Disability Result?

Nature and Extent

Surgeon's Charge—$

Signed______________________________

WORKS DISABILITY REPORT

Date Injured Returned to Work

Occupation

At What Rate of Pay?

Merit Bonus

Has This Accident Caused Injured to Suffer Any Loss of EARNING POWER?

Extent

Is Disabled Presented as a Candidate for Vocational Rehabilitation?

If Yes, Give Previous Occupations

Present Condition of Health

Education Poor Fair Good

Temperament

Attitude Toward This Company

Remarks and Recommendation

Signed______________________________

Manager
Superintendent

# APPENDIX F

DU PONT

## FINAL PERSONAL INJURY REPORT

WORKS | PERSONAL INJURY NUMBER
Name of Injured | Date of Injury
Has Injured Returned to Work? | On What Date?
At What Occupation? | Rate of Pay:

Time Lost Account of Injury.

From: AND From:
To: To:

Dates Excluded.

Total Working Hours Lost

Total Working Days Lost

Working Hours per Day:

Did Permanent Disability Result? | Extent:

SUMMARY OF EXPENSE:

Compensation
Temp. Disability $ representing weeks at $ per week.
Perm. Disability $ representing weeks at $ per week.

Medical Expense $
Professional $
Institutional $
Sundries $

Contingent Expense. $ representing

Total Expense: $

Prepared 19

MANAGER
SUPERINTENDENT

## APPENDIX G

DU PONT

# Foreman's Report of Personal Injury

____________________ 192

Name of Injured: ____________________ No. ________

Occupation: ____________________

Nature of Injury: ____________________

____________________ Time ________ A. M. / P. M.

Location: ____________________

(State definitely near or in what building injury occurred)

____________________

Cause: ____________________

____________________

____________________

____________________

Disposition made of injured ____________________

____________________

Witnesses ____________________

(Names and check numbers)

____________________

____________________

Remarks ____________________

____________________

(Continue on back of sheet if necessary)

____________________

(Name of Foreman and Number)

**NOTE:** REPORTS MUST BE MADE OF ALL INJURIES WHETHER SERIOUS OR NOT, AS SOON AS INJURY OCCURS AND FORWARDED AT ONCE.

## APPENDIX H

# TYPICAL ACCIDENT AND SAFETY COMMITTEE REPORTS

### DEPARTMENT ACCIDENT INVESTIGATION REPORT

*TO:* MR. J. S. Smith, *Plant Manager*

*Date* June 12, 1924

*The following is the result of a personal investigation of an accident which occurred in this area:*

*Date* June 12, 1924
*Name of Injured:* W. B. W————, *No.* WS-1797.
*Occupation:* truck driver.
*Building in or near which injury occurred:* Comene Storage.
*Nature of Injury:* Comene fumes.
*Description of Accident:* Removing valve from Comene cylinder.

The injured, W. B. W————, driver of Salvage Truck, has for the past 6 months transported Comene by truck from Comene Storage to operation, and was familiar with hazard involved.

He was instructed Thursday, June 12, to transport 25 cylinders, valved for operation, from storage to Bldg. 37.

While loading valved cylinders on truck, injured noted a leaky valve and, without authority and contrary to instructions he placed cylinder in vise and endeavored to tighten valve. This failing to overcome leak, he removed the offending valve without the use of gas mask, with the idea of replacing valve. Naturally, the cylinder was under pressure and spouted on removal of valve. He rushed from building, coughing severely and requested his helpers to go in and replace valve. They refused. After about 10 minutes, when the paroxysms had lessened, he donned a gas mask and after two attempts finally replaced valve (cylinder had spent itself).

He delivered cylinders to operation and returned with signed ticket, presenting same to foreman of Salvage without any further statement than one valve was leaking and he had fixed same.

Friday, following day, he reported to hospital for treatment for cold, making no mention of inhaling Comene fumes.

Saturday, did not report for work.

Sunday, June 15, he drove into hospital and told physician in charge of his experience with Comene fumes. Was treated and sent to W———— Hospital.

*Had injured been warned of this hazard by foreman?* Yes
*Was it possible to place responsibility for accident?* Yes
*If so, on whom?* Injured, disobedience of instructions.

*Nature of discipline recommended:* W——— is not a bonus man. We recommend that payment of bonus be deferred 3 months.

(signed)

| | |
|---|---|
| *Superintendent:* | A. T. Young |
| *Chief Supervisor:* | J. K. Addicks |
| *Asst. Supervisor:* | R. B. Petten |
| *Foreman:* | A. Jussi |

*Witnesses:*
Vincenti Sendra
M. Gerace.

*Action:* referred to Works Safety Committee for review, June 15, 1924
(signed) J. S. Smith, *Plant Manager*

## LETTER OF INSTRUCTION TO SAFETY COMMITTEES

TO ALL SUPERINTENDENTS:

May 13, 1922

I am outlining below the general procedure to be followed in handling the investigation of personal injuries, and the subsequent reporting and allotment of penalties in connection with such injuries.

*The Department Safety Committees will investigate all accidents occurring under their jurisdiction.* These Committees will report their findings to their Departmental Superintendents, the Superintendents will forward standard report forms covering each personal injury, fully filled out, to the Plant Manager, who, in turn, will turn the reports over to the Works Safety Committee for final review.

If the personal injury is due to faulty equipment in the Plant which can be corrected by minor repairs, repairs should be made immediately. If a personal injury is due to faulty equipment which involves expensive changes, a Minor Construction Account should be immediately prepared and forwarded to the Manager for approval. *If a personal injury is due to negligence or carelessness on the part of the injured employe, or a fellow employe, a suitable penalty should be recommended by the Superintendent and forwarded with the PERSONAL INJURY REPORT.* It should be the duty of the Works Safety Committee to review all Personal Injury Reports and penalties recommended. If it is the opinion of the Works Safety Committee that the penalty recommended by the Superintendent does not cover the case in question, whether in regard to leniency or severity, the Works Safety Committee shall discuss the question of revising the penalty with the Superintendent, and shall recommend that such a penalty be imposed as corresponds with penalties imposed in similar cases, if such information exists.

If the Superintendent whose employe is affected does not agree with the recommendations of the Safety Committee, the Superintendent can refer the case to the Plant Manager for final decision.

When cases arise in the various departments involving *habitual carelessness, or failure to follow prescribed safety rules, which do not result in personal injuries, it shall be the duty of the Department Safety Committees and Department Superintendents to deal with such cases as the seriousness of each case demands.* Each Department is rated, from the safety standpoint, upon

the number and nature of the personal injuries occurring under its jurisdiction. It is absolutely essential to eliminate employes who are willing to endanger themselves, or others, through habitual carelessness. All personal injuries due to carelessness reflect upon our entire Plant Safety Organization, but especially upon the Supervisor and foreman in charge of the careless employe. *Penalties should be applied in all proven cases of gross carelessness whenever it is found, regardless of whether it results seriously or not.* If this policy is strictly followed, personal injuries due to this cause should be almost eliminated.

C. D. Porch, Manager, Dye Works

## TYPICAL MINUTES OF SAFETY COMMITTEE MEETINGS

### TWELFTH MEETING OF THE FIFTH WORKS SAFETY COMMITTEE

APR. 25, 1923

PRESENT: L. C. Stone, Chairman
J. H. Burgess, Secretary
J. F. Dowd
E. R. Goodwin
H. W. Melson

ABSENT: A. F. Ormley

Copies to:
Plant Manager
Asst. Plant Manager
Production Superintendent
Engineering Department

Meeting was called to order at 10:30 a.m.

Minutes of the previous meeting were read by the Chairman and approved.

Chairman announced that the plant as a whole had completed a record of 69 days without a lost-time accident.

CIRCULAR LETTER ON "HORSEPLAY"

Chairman read a circular letter which he had sent to all Superintendents, calling attention to a near-accident due to "horseplay."

ACCIDENT OF L. GILBERT

Chairman advised that in connection with this accident, Plant Manager had requested the Safety Committee to formulate a uniform rule to cover the offense of failure to wear goggles.

Chairman was of the opinion that this might be done for the Chemical Departments, but that certain provision would have to be made for the Mechanical Department as it was positively impossible to wear goggles 8 hours a day during the summer time in the Welders' Shop.

Mr. Dowd suggested that a rule of this type should be applicable to a man who is noticed working without goggles, the same as to one who has had an accident. In other words, penalty should be inflicted before the fact, as well as after.

Secretary inquired as to the advisability of compiling data on eye losses in this plant, the cost, etc.

Chairman appointed Secretary and Mr. Dowd a committee to report at the next meeting with recommendations and a formulated rule covering the offense of not wearing goggles.

FAILURE TO REPORT TO HOSPITAL FOR EXAMINATION

This question was referred to in the meeting of April 18.

The following was the suggestion made by the M. I. Area Safety Committee for failure to report to the Hospital for examination:

First Offense—Reprimand.

Second Offense—Loss of one week's bonus and, if the individual is not making bonus, his pay to be reduced until the equivalent has been deducted.

Secretary suggested the removal of the employe's bonus, or where they are not making bonus at the time, that his bonus be delayed.

Chairman appointed Secretary and Mr. Dowd a committee to make some recommendations on this question.

MAKING UP GOGGLES WITH SPECIAL LENSES

Secretary reported that due to the condition of Gilbert's eyes he had not reported at the Hospital for an examination. He stated that special lenses will be furnished for men with defective vision.

REMOVAL OF HYDROCHLORIC ACID CARBOYS FROM BACK OF MECHANICAL AND TIN SHOPS

Secretary stated that a spur was going to be built to take care of this condition.

MELT POT USED AT THE SALVAGE DEPARTMENT

Secretary reported having taken this condition up with Mr. Burns of the Salvage Department, and that this would be taken care of by the Mechanical Department.

FREE CLOTHING

Chairman advised that the Plant Manager was very much in favor of this proposition provided a distinct rule be drawn up specifying just who was entitled to receive free clothing.

Chairman also advised having received replies from the various Superintendents as to the number of men whom they would care to grant this privilege, amounting to about 35 in all. At an estimated cost it was figured that $1,000 to $1,500 a year would finance the proposition.

Chairman appointed Mr. Melson and Mr. Goodwin a committee to draw up a definition of the men to whom clothing should be given. This should be specified by operations or certain sections of operations.

CONDITION OF BOX CARS

Chairman reported that a member of the Traffic Department was in the plant last week and he advised that a $10,000 project was in the process of approval for the erection of a Car Repair Shop which would be equipped to do all the local car repair work.

Secretary advised that good cars would be rented from the railroad until the plant cars were repaired.

ENGINEERING DEPARTMENT CLEANING UP THEIR WORK

Chairman referred to a portion of the minutes of the M. I. Area Safety meeting referring the question of the Engineering Department cleaning up their work to the Works Safety Committee.

Secretary stated that he thought it was an imposition to require the Transportation Department to clean up after the Engineering Department and thinks that they should prepare their construction needs accordingly,

from a financial standpoint. They claim that they do not have sufficient funds to do more than one clean-up.

The following motion by Mr. Melson was adopted and will be forwarded to the Engineering Department:

"It is the opinion of the Works Safety Committee that the Engineering Department has been negligent in the cleaning up of the debris resulting from their construction work.

"We feel that sufficient money should be appropriated to allow the Engineering Department to make frequent clean-ups, as deemed necessary, rather than to delay this until the work is completed and make one general clean-up."

TESTING OF PRESSURE VESSELS ON THE PLANT

Chairman advised no progress with the Engineering Department on testing and inspection of pressure vessels in the plant. He feels that there are considerable vessels in the plant that are carrying too high a pressure but that he is unable to get action.

Chairman stated that what they wanted to have done was to standardize the pressure vessels and prepare a schedule of inspection.

LIGHT FOR JITNEYS TO USE AT NIGHT

Chairman advised that Mr. Utrecht had submitted a type of light for the use of jitneys at night.

Secretary stated that this type had been approved and that an order had been placed for same.

CHANGE HOUSES FOR THE O & P LINE

Secretary advised that he had promised Dr. Katz some action on this change house question. In this area there are change house facilities for 15 men while there are about 60 men at work.

Chairman ordered this problem to be turned over to the Planning Department and that the location of the Cash Sales Store be suggested as a desirable location which might easily be obtained.

ONE-YEAR RECORD—O & P DISTILLATION SECTION

Mr. Melson reported the O & P Distillation Section as completing a year with no lost-time Accidents and suggested that the Chairman call this to the attention of the Plant Manager.

As there was no further business to come before the meeting, it was adjourned at 11:30 a.m.

## SIXTH MEETING OF THE TENTH WORKS SAFETY COMMITTEE

SEPT. 17, 1924

PRESENT: N. E. Hamilton, Chairman
J. H. Bright, Secretary
F. W. King
W. R. Bowen
L. H. Grace
E. A. Tripp
W. W. Underwood
E. B. Arnold

ABSENT: None

Copies to:
Plant Manager
Asst. Plant Manager
Production Superintendent

1. The meeting was called to order at 10:00 a.m. The minutes of the previous meeting were read and approved.

2. MAJOR INJURY (NEW)
MD-3142, A. WISE

Report on this accident was read. The opinion was expressed that this was a most full and satisfactory report. It stated that, owing to inability to transport to the burning ground a lead-lined catch tank which had been used for M. N. T., it was decided to take it apart on the job. Through a misunderstanding of orders, the work was not done correctly and a fire resulted, burning one of the men.

It was moved and carried that the report be accepted.

In discussing this accident, Mr. Bowen brought to the attention of the Committee the fact that material is frequently removed to the burning ground without notifying Stores, and several explosions have occurred there. Miscellaneous materials, often dangerous, are thrown in a pile for burning without informing Stores of its nature. He asked that such information be given in the future.

In further discussing the causes of this accident, the question was brought up whether mechanics working in operations do, or are expected to, report to the foreman of the operating building in which they are working. Mr. Underwood stated that it was a general rule in the Mechanical Department that this be done.

The following recommendations were made:

1. That mechanics should be requested to report to the person in charge of the operation.

2. That the supervisory force of the operating building in which work is being performed should take enough interest to correct workmen from the outside when they are working improperly from a safety standpoint.

3. SPARE MACHINERY

It was reported that work in getting rid of spare machinery is well under way.

Chairman read a reply from the Plant Manager to Safety Committee's letter of September 10, regarding clean-up work. He stated:

"I have requested Mr. Smith and Mr. Yates to comply with your suggestion. I have also asked Mr. Drury to allow sufficient money for clean-up work on all future minor construction orders."

Chairman also read letter from J. W. Cling regarding the sending of uncleaned machinery to Excess Machinery Stores which stated:

"You are, no doubt, familiar with the ruling of the Management which requires that all machinery be thoroughly cleaned before being brought to our yard. There are several reasons why the equipment should be cleaned by the operation rather than by the Stores Department. Probably the reason that you would be particularly interested in is safety. If equipment is returned to us without having been cleaned, it is likely to contain almost any kind of a chemical and our men would not know what kind of safety precautions to take as they would have no way of telling what kind of material had been used in the machine. For instance, sometime ago, several pots were turned into the Extra Machinery Yard that had not been cleaned and we found that they had been used in some process that used metallic

sodium and that sufficient quantity of this sodium was still on the pots to cause considerable trouble had we attempted to wash them out.

"We would thank you to call to the attention of all concerned the importance of thoroughly cleaning all equipment before returning same to our Extra Machinery Yard."

Chairman requested each member of the Committee to make inspection of yard in their allotted area and report on the progress of clean-up work at next meeting.

With regard to the proposition of the areas handling match searches and the question of smoking, it was reported that, so far as replies have been received, they are favorable to this idea.

4. SHOWERS—T. & M. AREA

Chairman stated that this matter had been taken up with Mr. Bowen and he did not believe that anything would be gained by changing from raw to filtered water. It was found that these showers are rusty and need cleaning. No further report than this is available at this time.

5. SAFETY BULLETIN—ELECTRIC CONTROLS

Mr. Underwood stated that he had ordered the painters to mark all push button controls and that all equipment now installed is being so marked as per *Safety Bulletin* 372 so that proper control is readily noted and operated. The matter was laid on the table for further discussion next week when plant bulletin covering this will be discussed.

6. GLOVES

Chairman read a letter on the subject of the distribution of gloves dated Oct. 4, 1923, as follows:

"The Works Safety Committee has carefully investigated the use of rubber and leather gloves in each department and has recommended the following general regulations in regard to supplying these:

"1. That rubber gloves be furnished wherever the nature of the operation justifies wearing them.

"2. That the life of a rubber glove be taken as 1 month and that operators be charged with the responsibility of getting this life from the glove.

"3. That, where it is advisable, leather gloves may be given out instead of rubber gloves for handling poisonous compounds.

"4. That for all other operations than those specifically designated in the General Rules, no free gloves be given, but, at the option of the Superintendent, leather gloves be sold at half price.

"5. That the Works Safety Committee check up periodically the use and consumption of gloves on the Works.

"6. That dirty rubber gloves be sent to the laundry for cleaning and returned to the operation."

The Committee felt that these six items covered the points under discussion, and wished to go on record as checking them as they stand. At the same time, the Committee desires comments from those interested upon the glove situation. Mr. Bowen will get information from the Stores regarding the number of pairs of gloves issued during the year.

NEW BUSINESS

Chairman read part of *Safety Bulletin* 375. The suggestion was made in the margin of this bulletin that it might be advisable for the works to handle

the chairmanship of area safety committees as is done at Athlone Works, namely, chairman keeping his position until a major accident occurred when he is relieved automatically by the occurrence.

The suggestion was discussed and several modifications suggested. It was decided that a letter be sent to each area safety committee with this paragraph, asking for comment.

SAFETY BULLETIN 376

Chairman called attention to the above which gives a list of safety bulletins which should be on hand at all plants, and stated that a copy of it would be placed in the hands of each member of the Committee and the subject of the best way to make use of same on this plant would be brought up at a later date.

SAFETY SHOWERS ON ACID-LOADING PLATFORMS

Mr. Underwood brought up this subject, stating that men receiving burns while working on acid-loading platforms would be in a bad position, having to climb down the ladder to hunt up a shower, and suggested that showers be placed on the platforms. It was moved and carried that the Committee suggest the extension of showers to platforms at all acid- and alkali-loading spots where a raised platform is used.

Meeting adjourned at 11:30.

## MINUTES OF MECHANICAL DEPARTMENT SAFETY COMMITTEE MEETING

DEC. 15, 1924

PRESENT: V. Z. Fenton, Chairman
P. C. Boyden
E. Smith
J. Stoll
H. G. Friedman
T. G. Kling, Superintendent

Copy to·
A. M. Young, Chairman
Works Safety Committee

9½ months without a time-losing accident.

INJURIES

Frick was working in S. B. A. House prying a wooden block apart with a chisel bar when the bar slipped and struck Frick in the eye, resulting in contusion and laceration of right eyelid. Submajor injury. Responsibility was placed on foreman in charge.

COMPLAINTS

Complaint has been received several times that the men cannot get enough hot water to bathe in. To rectify this condition, order has been placed for brass pipe. This will be installed in place of the iron pipe that is there at the present time. This iron pipe corrodes and rusts which prevents water running through. It was also suggested that globe valves be used instead of gate valves.

Boyden advised that there was a bad bridge at the old Power House which is used for unloading material. This will be fixed up.

Stoll advised that at times it was necessary to work in the car repair shop at nights and it is not equipped with lights. Mr. Kling said that lights should be installed.

Compressor room at the boiler shop has no lights. We will put one in.

Friedman advised that there was a bad trap at No. 53. One of our men barely escaped being burned. Called this to the supervisor's attention.

LADDERS

All the ladders in the mechanical department are to be kept together in a shop, fixed up for this purpose, and the key is to be kept in the mechanical office. Mechanics will take these ladders out on tool checks.

SAFETY INSPECTION

In the pipe shop it was found that the chain fall had not been repaired. Found scrap pieces of pipe scattered around in the middle of the floor. Chairman suggested having a box placed near the pipe-bending machine, so that pipe can be thrown in as it is cut off. The committee noticed that pipe is unloaded in back of the shop across a concrete road and in order to get in to the shop it has to be carried across two tracks. This is a hazard in that the men cannot see where they are going when they have long pieces of pipe on their shoulders and are very liable to fall over these tracks. It was suggested that we plank in between the tracks.

In the car repair shop they have ledges 4 to 6 inches wide on which are placed bearings, etc. This is very dangerous and Chairman asked Mr. Smith to see that this material is taken off these ledges.

In the welding shop it was suggested that a small door be cut in the large door. Mr. Kling advised that this be done.

In the carpenter shop found strips of wood standing up against the belt guards.

In the different shops found drinking water bottles which were very dirty, and at which a permanent cup is placed. This should be taken away, bottles cleaned and sanitary cups placed at these bottles.

Meeting adjourned 11:50.

## MEETING OF T & M. AREA SAFETY COMMITTEE

DEC. 23, 1925

| | | |
|---|---|---|
| PRESENT: | B. F. Yarrow, Chairman | Copy to: |
| | O. James | J. J. Carter, Chairman |
| | E. Barnes | Works Safety Committee |
| | B. Little | |
| | J. Ivanovitch | |

Meeting called to order at 11:00 a.m. and minutes of previous meeting approved.

Report relative to number of days without time-losing accident:

| | |
|---|---|
| Plant | 126 days |
| T. & M. | 768 days |

STATUS OF MECHANICAL REPAIR WORK

| | |
|---|---|
| New railing on platform No. 2 mixer | Completed |
| Hook on basket on air hoist, Bay No. 3 | Completed |
| Steam hose replaced | Completed |
| Cone on No. 5 L. M. repaired | Completed |
| Barrel skids replaced | Completed |
| Covers for mixers, Old House | Completed |

| | |
|---|---|
| Placing of pole and electric light near change house leading to Clock Alley | Not complete |
| Slat platforms in Change House | Not complete |
| Drilling holes in "A" and "8" Mixers | Not complete |
| Repairs to floor inside No. 145 Stores | Not complete |
| Fastening iron railing second floor, Old House | Not complete |
| Light Switch No. 4 | Not complete |
| End sill second floor at elevator, Old House (Repair Order placed) | Not complete |
| Ladder placed outside building to oil line shaft Nos. 1-2-Mixers, (Repair Order placed for platform instead) | Not complete |
| Handle on clutch "A" mixer to be lengthened | Not complete |

SUGGESTIONS

Mr. Ivanovitch:

Floor along edge of hopper No. 5 L. M. is in dangerous condition. Cement broken away far enough to allow man's foot to go through. Opening should be closed.

Steam line Nos. 1 and 2 rooms to be lengthened to have hose connected in center of room instead of corner.

Mr. Little:

Clamps on doors on Nos. 8, 9, 10 and 11 mixers should be repaired to allow perfect tightening and gaskets renewed on Nos. 9, 10 and 11 mixers. It is impossible to have a dustproof grinding in present condition.

Mr. Barnes:

Doors at Old House to be overhauled—new cables and weights used where required.

Switches near No. 144 and No. 145 to have levers put on. Levers to have handles.

Ground asbestos should be gotten for paste. In gathering old asbestos to be used there is danger in cutting hands. Last week a man cut his hand with a piece of glass imbedded in material and at other times found bits of wire.

Sheet-iron boxes at mill should have corner cut diagonally to allow more space to use wrench to tighten cone on mill when setting up. Sheet of tin placed from top of mill to box on floor to prevent dye from falling on floor between mill and box.

When small sink is removed from Change House have steam coil put in its place for heating.

Double gates at entrance to plant are only partly opened at 8:00 a.m. One gate is closed entirely—other open. At this time of night workers are coming off shift and getting to trolley cars and there is some confusion. Trucks, cars and men are coming and going to and from the plant, and opening of one gate is entirely too small for safety of men on foot. The Committee is of the opinion that for successful and cooperative safety in and around the plant a man should be protected even after ringing the clock going off shift.

The Committee pledges cooperation in furthering the plant safety record made to date.

Mr. Ivanovitch and Chairman inspected Change House and no matches or evidence of smoking were found.

HOUSEKEEPING

| | |
|---|---|
| Old House | Good |
| Old Dry House | Good |
| Ball Mill | Fair |
| No. 144 Stores | Good |
| No. 145 Stores | Good |
| Bay No. 3 | Good |

Meeting adjourned at 11:55 a.m.

(signed) J. F. Yarrow, Chairman

## MINUTES OF NO. 3 AREA SAFETY COMMITTEE MEETING

JAN. 8, 1926

W. C. Bacon, Chairman
L. S. Thomison
A. Proukowski
M. L. Tittoni

Copies to:
Works Safety Committee
Mr. A. J. Brown, Manager

The regular monthly meeting of the Committee was called to order by Mr. W. C. Bacon, Chairman at 2:00 p.m., Friday, Jan. 8, 1926, in the Tank House. All present.

The minutes of the previous meeting were gone over and it was noted that all the recommendations and work lined up had been either finished or was well under way. Among the work finished was the painting of hanging chain-hoists red, elevator pits and gates put into shape, platforms at 1–2C finished, Change House painted, lockers cleaned out, renovated and painted. The storehouse painting is nearly finished and the main building is to be started on next. The job being done is quite satisfactory as to quality of work and cost. It is being done by the Mechanical Department with the gun. The plate is in for the drain covers in the dry room.

NEW BUSINESS

Under new business, attention was called to a number of points brought out in the Works Safety Committee minutes, such as use of the two types of goggles, wearing of torn clothing, or gloves, blowing of ventilator covers and other material off roofs (this point was checked previously and the roof is all cleared off) and use of milk bottles for samples. Attention was called to the clock alleys being filled before 4:30, and the No. 3 Area cards being held until 4:30 before being given to the men. This gives the others first chance at seats in the trolleys but our ruling stands.

Attention was called to the safety gate off at the dry room corner. A letter will be sent to the Safety Engineer notifying him of this, also suggesting a double gate. This would necessitate stopping at this point but we consider this a very dangerous point especially at the high rate of speed at which some of the jitneys pass by it. In the same letter his attention will also be called to the irregular removal of dried color from our platform. This causes a jamming of color on the platform and in the dry room, which would be a very bad hazard in the case of a fire.

It was suggested that a cinder path be run to the Change House from the building. For the handling of acid for the upper 15–17C tubs, it was

suggested to place a platform and crock above these tubs feeding by gravity into them and to be fed from the main line into the building. This would eliminate the handling of carboys by the hoist which is slow and somewhat hazardous.

It was suggested that the overhead belts on the graining bowl should be guarded, as a man works directly under them and when the door is open the belt hooks scrape the top of the door. This will be taken up immediately with Mr. Fenton. Also a rail should be put on the platform to the ventilator to the roof for cleaning purposes. Also cover the hole in the floor—this is under the bowl. Also fasten firmly the blow-off line from the pop valve on the rotary drier. Also repair hole in floor in rotary drier motor room.

The plant record of 142 days was discussed and everyone was urged to do his utmost in continuing it to 150 days and further.

The daily inspection reports are serving a very useful purpose in taking care of safety, power and housekeeping.

It was suggested that the minutes of the Works Safety Committee, besides being posted on the board as they are at present, also be read very carefully by the Foremen to the men unable to read English; also our own minutes. This will make sure that everyone is acquainted with the safety work going on in the plant and by No. 3 Department.

On the large sliding doors which are difficult to open and close, it was suggested that a small hinged door be put in the center of the large door with weights to keep it closed. Attention was called to the inefficiency of our present method of washing pans, driers and barrels, and any suggestions for improvement will be given careful consideration.

In order to cut down on power we have all got to keep everlastingly at it.

No further business. Meeting adjourned at 2:40 p.m.

(signed) W. C. Bacon, Chairman

# APPENDIX I

## NO-ACCIDENT CONTEST RULES
## E. I. DUPONT DE NEMOURS AND COMPANY

### TABLE SHOWING CLASSES AND GOALS

| Average Payroll Hours per Month | Class | Period (Consecutive Working Days) |
|---|---|---|
| 400,000–500,000 | A | 60 |
| 300,000–400,000 | B | 100 |
| 200,000–300,000 | C | 150 |
| 125,000–200,000 | D | 225 |
| 62,500–125,000 | E | 375 |
| 31,250– 62,500 | F | 600 |
| 12,500– 31,250 | G | 750 |
| 2,500– 12,500 | H | 900 |

### RULES OF THE CONTEST

1. The competition will be in effect Apr. 1, 1923, but will be retroactive in the sense that each plant will start its no-accident record from the date of its last tabulatable injury.

2. The record must be consecutive and unbroken by accident occurrence, but may be interrupted by a shutdown of operations.

3. Plants which change from one of the above classes to another will be credited with a proper proportion of the record already achieved.

4. The Safety Division, with the consent of the General Manager, will act as judge on any question under controversy and will recommend to the President the granting of an award when in its judgment a plant, etc. becomes eligible.

# APPENDIX J

## HOUSEKEEPING RATING REPORT

Area.......................... House

Mr...................... ...

A housekeeping inspection of your house on .......... resulted in assigning to it a merit rating of . . out of a possible 100 %.

The following is a detail of the merits assigned for various conditions and those obtained by your house:

| | Credits Obtainable | Credits Obtained |
|---|---|---|
| 1. General appearance of floors ....... . . | 5 | |
| 2. General appearance of paint. ..... . . . | 10 | |
| 3. Disposition of spare parts.. ... ... .. | 5 | |
| 4. Storage of material............. . . . . | 10 | |
| 5. Conditon of elevator pits and gates . . . | 10 | |
| 6. Condition of pipe work, hangers, leaks . | 10 | |
| 7. Condition of transmission, guards... | 10 | |
| 8. Condition of machinery and apparatus . | 10 | |
| 9. Condition of showers, green lights .... . | 5 | |
| 10. Conditon of electrical equipment, accessibility of starting boxes, and insulated platforms . | 5 | |
| 11. Condition of radiators . . | 5 | |
| 12. Condition of lights and windows . .. | 5 | |
| 13. Condition of exits..... . . . | 5 | |
| 14. Condition of platforms and grounds.. . . | 5 | |
| | 100 | |
| HANDICAPS | | |
| For poor original construction ...... | 10 | |
| For repairs under way ..... ... ....... | 10 | |

Conditions in this house needing special attention are:

WORKS SAFETY COMMITTEE
Inspectors ..

# APPENDIX K

## TYPICAL QUESTIONNAIRES

### QUESTIONNAIRE TO DEPARTMENT SUPERINTENDENTS

The Safety Committee, appointed by the Management to carry on the campaign from Mar. 1, desires to continue the work so well started by the previous committee and to this end requests the support and cooperation of every Superintendent, Supervisor, Foremen and Employe in the plant.

In reviewing the work of the outgoing committee we find there were six specific suggestions made and we are desirous of learning what effort and progress has been made in following these out. Perhaps we can help you if difficulties have been encountered; at least, will you kindly answer the following questions in detail so that we may have a complete record of your activities with reference to these suggestions?

1. Are your Supervisors and Foremen bringing safety to the attention of their men?
2. Do you hold weekly meetings and devote time to the discussion of safety? (Please give date and time these meetings are held.)
3. Do you report accidents after a thorough investigation?
4. Is housekeeping being given the attention it deserves?
5. Do you regularly have safety and housekeeping inspections made of your building and equipment?
6. Has Rule 2 of the General Safety Rules been complied with?

The Committee feels that any employe selected at random on the works when asked "Have you been spoken to about safety?" should reply in the affirmative.

The new committee intends to follow up the recommendations made by the previous committee in its plant inspection reports and will see that they are put into effect.

WORKS SAFETY COMMITTEE

### QUESTIONNAIRE TO SUPERVISORS

1. Why is the teaching of safety desirable or necessary for all employes in a plant?
2. Have you any idea as to the number of persons accidentally killed and injured in the United States annually?
3. Why should safety work in a plant be organized?
4. What are the most common hazards or causes of accidents in your department?
5. What in your opinion are the most dangerous types of machine tools in your department?
6. Why should you regularly inspect your department from a safety standpoint?

7. Do you insist that a workman when slightly injured, cut or bruised, go to the first-aid department and why?
8. Do you understand the prone pressure method of resuscitation?
9. How would you keep the subject of safety constantly before the workmen?
10. Do you believe in guarding equipment; if so, why are so many guards removed and not replaced?

(Please return your replies to Works Safety Committee)

## QUESTIONNAIRE TO SUPERVISORS AND FOREMEN

The new Works Safety Committee as of Oct. 11, 1922, desires to eliminate accidents from our entire plant and solicits your hearty cooperation, as without it our efforts will be in vain.

With this aim in view we are issuing the following questionnaire:

1. Will you help us in our work?
2. Will you see that safety is constantly before your men?
3. Will you have all minor injuries promptly sent to the Hospital?
4. Will you see that the General Safety and Area Rules are strictly enforced?
5. Is there anything embodied in these rules that cannot be followed?
6. What suggestions have you to offer toward greater safety?

WORKS SAFETY COMMITTEE

## QUESTIONNAIRE TO FOREMEN

Jan. 28, 1924

The Works Safety Committee firmly believes that we can better our safety record only by training each man to work in a safe and careful manner. We have found that it is impossible for us to reach every man individually, and think that if every foreman throughout the plant is a safety worker, every man under him can be educated along safety lines.

Each foreman should know that every man under him has been taught the safe method to perform his work and should see that every man does his work in the prescribed way. You should feel personally responsible for every worker and be on the lookout for hazards and bad practices. You should stand back of every safety movement, practice safety yourself and be a safety leader for your men.

In an endeavor to acquaint the foremen with their responsibilities, and in trying to uncover unsafe conditions, the Committee is going to submit, periodically, a few questions to each of the foremen. These questions will relate to the work the foreman is actually engaged in and should be answered as fully and as thoughtfully as possible, making every effort to answer them to the best of your knowledge and giving your views plainly, for it is only by your cooperation that we can hope to benefit by this procedure.

1. How long have you been employed with the company in your present capacity?
2. Are you familiar with the safety standards which apply to your work?
3. Have you been convinced of the good accruing from a true safety-first movement?

4. Do you know that each of your men has been taught the safest manner to perform his work?

We hope you will give these questions as much time and thought as possible before answering them. We hope to have them answered in the same spirit as they are given—with an earnest desire to improve our accident record. The committee believes that if certain safety duties of the foremen are brought to mind by these questions, they will cooperate with us to educate each man. Only when we have accomplished this will we be operating with 100% safety.

SAFETY COMMITTEE

QUESTIONNAIRE TO FOREMEN

1. Name some of the principal hazards existing in your operation, which require special supervision.
2. What precautions in the way of supervision are taken against the above hazards?
3. Are you personally sure that all new men coming under your supervision (whether newly employed or transferred from another department) are thoroughly familiarized with the hazards connected with their new work?
4. If so, outline briefly how such educational work is carried on.
5. Do you follow up suggestions made by your men; either having their suggestions carried out or explaining to them satisfactorily why such suggestions should not be followed?
6. The safety rules and regulations of the plant are a safeguard against all well-known types of accidents. How can we be sure that all these rules and regulations are strictly enforced at all times?
7. What do you consider the essential factors in good supervision with respect to accident prevention?
8. What other suggestions can you offer to reduce the existing frequency of injuries?

Signature . . ............

QUESTIONNAIRE TO EMPLOYES

1. Do you know of any unsafe condition existing around your work?

2. If so, what have you done to remedy same?

3. If you reported such a condition to your foreman and no action was taken, what would you do next?

4. What is the name of the man who at present represents your building on the Area Safety Committee?

5. If you operate an elevator, do you thoroughly understand the rules governing same?

6. If you were on the third floor and the elevator on the first floor, what would you do if you wanted to use it?

7. When did your foreman last talk to you about safety?

8. If you were transferred from one operation to another, would you assume any duties until you thoroughly understood the details of your new job?

9. Do you watch out for your fellow workman as well as for yourself?
10. Do you know there is no excuse for not reporting to the hospital with an injury no matter how small?
11. In case you had an acid spill are you sure your nearest acid shower would work?
12. How many days has the plant gone without a time-losing accident?

(Please answer these questions and return to your foreman in the attached sealed envelope.)

## TWO QUESTIONNAIRES TO EMPLOYES

Mr. . . . . . . . . . . . . . . . . .

Two years and nine months without a lost-time accident is our record as of 9:15 a.m. today.

Our 3-year goal is but one step ahead.

Can we put it over?

Please write your comments on this sheet and return to the writer at once.

Superintendent. . . . . . . . . . .

Mr. . . . . . . . . .

*Remember the ABC of Work—Always Be Careful*

You have personally just established a NO LOST-TIME Accident Record of 3½ years for our Department.

No matter whether you have been in the Department 3½ years or 3½ hours this record would have been impossible without your safety efforts.

Let's tackle the next 3 months with renewed effort and energy.

What safety suggestions have you to offer?

Did you ever make any safety suggestions that were not carried out?

If so—were you shown to your satisfaction that they could not or should not be adopted?

If so—what were they?

Let's have more.

Please answer and return at once to

. . . . . . . . . . . . Superintendent

## QUESTIONNAIRE TO DEVELOP SPECIFIC INFORMATION

Recently a Department on this works was found to be using the canister type gas mask for protection of men entering closed equipment where there might have been insufficient oxygen to sustain life. Also the men entering such equipment were not wearing life belts

In view of the possibility that such practice may be common in other Departments we are issuing the attached questionnaire in the hope of getting this service as nearly 100% as possible.

Will you therefore kindly answer the following questions and return to the Works Safety Committee as soon as possible so that some action may be taken in this matter at an early date?

1. How often do you have to send men into closed apparatus (closed with exception of manhole, etc.) that might contain poisonous gas and fumes? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
2. What protection (as gas masks, life belts, etc.) is afforded men entering such apparatus? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
3. Is it ever necessary to enter such apparatus on the night shifts? . . .
   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
4. Do you think the procedure you follow in entering closed apparatus (tanks, etc.) entirely satisfactory? . . . . . . . . . . . . . . . . . . . . .
   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
5. Do you think it practicable to have the necessary safety devices for protection of men entering closed apparatus carried by the Safety Department and, when an Area has such work to do, to secure the necessary equipment from the Safety Department, same to be returned immediately after completion of such work? . . . . . . . . . . . . . . .
   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

REMARKS:

Signed . . . . . . . . . . . . .

# APPENDIX L

## THE TANNER TRAGEDY

The great day in the lives of William and Mary Tanner came to pass on Sept. 2, 1919. They had gone to Hubbard Woods, a modest country village not far from Chicago. Bill Tanner was on his annual holiday and Mary and the kids were with him. The man and his wife had been invited to have dinner with friends a mile or so down the road that ran through the woods and across the tracks of the Chicago and Northwestern Railroad The kids were left behind in charge of Bill Tanner's mother. Mary and Bill would be home before the children's bedtime.

The grade crossing at the Northwestern tracks is one of those plank affairs, solid except for the slot along which the rails run. You've seen the same kind many times.

Mary Tanner's foot—it was a small foot—slipped into the groove almost to the ankle. In such a manner did her foot enter the opening that it became wedged tightly between the steel rail and the planking. The flagman at the crossing was lowering the gates. A train—the heavy afternoon express—had just passed the station beyond, two miles up the track. A curve in the roadbed and the heavy woods lay between Hubbard Woods station and the onrushing express.

Bill Tanner tried the advertised expedient of loosening his wife's shoe. The scheme did not work. The foot was as tightly wedged between the rail and the planking as ever. Faintly the roar of the locomotive was heard. The flagman ran across the tracks. In something of a panic he and Bill Tanner sought to wrench the woman free. The pain was too much for Mary, and she fainted. A mile up the track the train rounded the curve. It was doing better than 50 miles an hour.

One doesn't attempt to explain these things, but Mary Tanner revived. She saw the train and knew what it meant. She told her husband to leave her; to save himself; to do so for the sake of the children and his mother.

That was Mary Tanner's great moment. What woman would not like to think of herself possessed of that sort of courage and unselfishness?

But Bill Tanner did not leave her. "I'll never leave you, Mary," was his simple reply. And he didn't. The flagman jumped. The steam chest of the train struck him. He went hurtling to the far side of the roadbed. Bill Tanner had folded his wife in his arms, had placed himself between the train and the woman he loved and closed his eyes.

Thus died William and Mary Tanner—the unromantic, clean, God-fearing pair who had never shown anything that distinguished them from several million folks who plied an everyday existence under the same sun and the same clouds that canopied their days of uneventful life.

# APPENDIX M

## THE WISNIEWSKI CASE

Since the death of her husband a few months ago, Mrs. Mary Wisniewski, 32, of 68 Avenue C, Newark, has toiled in a factory to support herself and 2-year-old daughter, Josephine. Last week her left hand and arm were crushed in a machine at the factory.

Yesterday afternoon, accompanied by a neighbor and carrying little Josephine, Mrs. Wisniewski was crossing Franklin Street at Emmett, Newark, on her way to the State Department of Labor Building to claim compensation for her injury, when a motor truck bore down on them.

As Michael Rahia of 384 Second Street, Jersey City, struggled to apply the brakes the child was struck by a front mud guard and hurled under a rear wheel. Screaming, the mother sprang after her child in a futile attempt to save her, and a wheel passed over her own left foot.

Mother and daughter were put in a taxicab and hurried to St. James' Hospital, Newark. Josephine was dead when they arrived.

A few minutes later Mrs. Wisniewski's injured foot was amputated. She was not told of the death of her child. Physicians are confident the mother will recover.

# APPENDIX N

## FORM LETTER TO NEW EMPLOYES

NEW EMPLOYE: THIS IS A MESSAGE TO YOU ON SAFETY

We want you with us, and want your service to be long, prosperous, and free from accidents and injuries. To accomplish this we must have your cooperation.

Do your work in a safe manner, so as to protect yourself and others. Should you have an injury, even a minor one, such as a bruise, cut or particle in the eye, report to your foreman immediately and go to the Hospital. Do not wait until night or the next day, as infection may set in.

A glass eye may look well, but is no good to see with. Wear your goggles when working around places where small particles are likely to fly, or around acid lines.

Before working on scaffolds or ladders, examine them yourself and make sure they are safe. Do not take another's word for it, as you are the one who may suffer from a fall.

Do not hesitate to ask your foreman for information regarding the operation you are conducting. Remember everyone was a beginner at one time. He will be glad to help you.

Let SAFETY FIRST be your motto in all work.

I have read this message, and have received instructions on the general rules.

Signed.. . . . .. .... .(Employe)

# APPENDIX O

PLANT ____________ 19__

**CHANGE OF RATE**
**CHANGE OF OCCUPATION**

SURNAME ____ GIVEN NAME ____ NUMBER ____

PRESENT OCCUPATION ____

NEW OCCUPATION ____

PRESENT RATE ____ DAY / PER HOUR ____ NEW RATE ____ DAY / PER HOUR

NEW RATE TO TAKE EFFECT ON ____

REASON ____

(OVER) ____ SUPT

INCREASED RATE APPROVED ____ REPORTED ____

FRONT

DATE____________________

I have on this date personally instructed this employee on the following:

1. General Rules pertaining to the plant.
2. House Rules pertaining to the particular operations in which he is to be placed.
3. Hazards of the materials he is to handle and the necessary precautions that must be observed.
4. The importance of reporting ***all injuries no matter how trivial.***
5. The importance and use of safety appliances in his work
6. The value of the materials handled and the importance of keeping down waste.
7. The importance of personal and plant cleanliness.
8. The responsibility that is placed upon him in properly carrying out instructions and obeying rules.

(S)____________________
Foreman or Supervisor

REVERSE

# APPENDIX P

## A BRIEF DESCRIPTION OF MERIT RATING[1]

Under the merit rating system, the insurance rate for a plant is possible of development in three steps: The first, of course, and the only one until the establishment of merit rating, is the classification of risks into groups so as to differentiate one industry from another and assign it a basic rate proportionate to its own degree of hazard. The manual rate, so-called, which is thus developed, is based upon the experience of the industry as a whole and gives no recognition to those plants in an industry which for one reason or another are able to have a loss experience more favorable than that developed by the industry as a whole. It was to meet this inequity between different plants in the same industry that the merit rating system was devised. This system consists of two parts, schedule rating and experience rating. Schedule rating undertakes to vary the manual rate of a plant according to the greater or less probability of its having the average experience of plants in its industry. It has been well termed "a plan for the reclassification of risks within the manual classification." It accomplishes this reclassification by noting through careful inspection the physical and mechanical conditions of the individual plant, and developing credits or debits as these are found to be in good condition or otherwise. In this way the physical hazards of a plant are measured.

### Schedule Rating

Schedule rating has been refined gradually but steadily ever since it was first established, until it now measures with a very fair degree of accuracy the physical hazards found in a plant. This refinement has been done by classifying and listing causes of injury and noting the losses resulting from it. In this way the respective weights which should be attached to the several causes have been determined from actual experience. Let us take furniture manufacturing plants as an example. In these, it was found, upon research into the country-wide experience of the members of the National Bureau of Casualty and Surety Underwriters, that 66% of the losses are due to five principal causes, namely:

| | % |
|---|---|
| Elevators | 1 5 |
| Power transmission | 1 5 |
| Machine-driven devices | 1 |
| Machine moving parts | 7 |
| Machine point of operation | 55 |

[1] David Van Schaack, "The Part of the Casualty Insurance Company in Accident Prevention." Reprinted from the Jan., 1926 issue of The Annals of the American Academy of Political and Social Science, Philadelphia, Pa., edited by Richard H. Lansburgh, Vol. CXXIII, No. 212.

The experience from which these percentages are derived covers such a wide range that they may be considered fairly dependable, and the schedule, therefore, gives each of the causes making up this experience its proper weight. Eliminating this 66%, there is still 34% of accident loss cost to be attributed to other causes of accidents. It is not possible to trace this 34% so conclusively to its separate causes as can be done in the case of the causes already mentioned, so the schedule undertakes to cover these, which include physical, mental and even "moral" causes, by what is known as safety organization. Under this section the schedule gives a credit for certain definite features of safety organization, including supervision, inspection and safety education, as well as medical treatment, all of these having an effect upon the whole hazard of the plant as well as an influence upon the miscellaneous causes to which it is difficult to attribute accidents so directly. The application of the schedule to the conditions of the individual plant, therefore, varies the manual rate according to whether these conditions are good or otherwise, and to what steps the management of the plant has taken to safeguard its employes against accident, to educate them into safe habits of working, and to take care of such accidents as may develop despite all the precautions taken.

Schedule rating was a long step toward the proper adjustment of rate to an individual plant within a given industry, but it is not applicable to risks of all kinds for, as will be readily inferred, its principal application must necessarily be to risks which have a considerable mechanical hazard; nor is it applicable even to those in the case of plants of all size. The annual premium of a risk can be too small to justify the expense of inspection and rating under the schedule rating plan, and such risks, therefore, are rated simply on the manual basis. When a premium is large enough, and there is sufficient estimated annual payroll to justify the necessary inspection and survey work, schedule rating is applicable. Such risks get at least one rating inspection each 2 years with an interim survey each year, and the ones of larger premium are inspected annually and get from one to two interim surveys each year.

These inspections are made in one of two ways—either through a central inspection bureau supported by the companies or by the companies individually; in the latter case the company inspections are filed with a central bureau for checking and promulgation, and usually this authorized bureau is called upon to inspect new risks for all companies as well as to check renewals by inspecting risks selected at random, thus getting an idea of how closely the inspector of the company itself has followed the schedule. Under either system there is still much left for the individual company to do. If it is keenly interested in the retention of its business, it will not be satisfied with letting the bureau inspector simply record conditions as they are for the purpose of determining the correct rate, but it will inspect the risk itself with a view to pointing out to its assured how, by the making of certain improvements, his rate will be favorably affected. The individual company is, therefore, bringing constant pressure to bear upon its assured to make possible further reduction of his rate under schedule rating by having all the physical and mechanical conditions of his plant brought fully up to standard.

## EXPERIENCE RATING

Experience rating, so far as manufacturing risks are concerned, is used further to modify the manual rate, or the manual rate as adjusted by schedule rating, to make it fit the individual plant. Schedule rating cannot be completely effective in this respect even as regards manufacturing risks, for it deals principally with physical hazards, and its operation cannot demonstrate whether the granting of a credit for the so-called "morale" items—such as complete safety organization and proper provision for medical service—is really justifiable. Nor can its operation fully justify the credits which it may give for the installation of physical safeguards which, in order to be really effective, must be both kept in good order and used by the workmen. Experience rating, being based upon the actual loss experience of the plant, shows to what extent the provisions for which credit is given by the schedule rating plan really do affect the plant, and then proceeds to adjust the premium in accordance.

In the case of other than manufacturing risks, experience rating furnishes the only possible means of applying the general principle of merit rating. It determines the variation of the individual risk's experience from the average experience of risks in its manual classification, and thus makes it possible to modify, for the individual risk, the manual rate.

As in the case of schedule rating, it is not practicable to apply experience rating to all risks. In the case of some, the experience is too limited. Where the experience of the individual risk is comprehensive, however, the result it shows may be depended upon with fair accuracy, and will, therefore, justify a variation, often considerable, from the manual rate. The formula for experience rating involves some factors which are too complicated to be discussed briefly, but it may be summarized in the statement that it takes into consideration both the payroll exposure of the individual risk and its hazard as shown by actual loss experience.

## MERIT RATING

The entire system of merit rating, which was first devised by the casualty companies and ever since then has been constantly refined with a view to making it more accurate, is undoubtedly the greatest single influence in the promotion of accident prevention in industry. Schedule rating offers the individual plant, having or developing good physical conditions and undertaking "morale" work, the incentive of a rate variation based upon the probability of such a plant having a better loss experience than the average of its industry, upon which, of course, the manual rate must necessarily be based. The estimate of this probability is founded upon actual loss experience in the industry showing that certain physical conditions do tend to reduce accidents from definite causes, and also upon the fact that "morale" work, if properly carried on, will have its effect too upon accident occurrence and severity. Experience rating, in the case of the manufacturing plant, is able to modify the rate more precisely and more justly because it is based upon the actual loss experience of the plant, and is thus enabled to go beyond the probability of accident prevention into the definite field of real accomplishment. As far as other than manufacturing plants or operations are concerned, experience rating offers the only means at all dependable of modifying the manual rate on any scientific and therefore justifiable basis.

# APPENDIX Q

## AMERICAN ENGINEERING STANDARDS COMMITTEE SAFETY CODES

Lighting Factories, Mills and Other Work Places (American Standard)
Safety Code for Ladders (Tentative American Standard)
Safety Code for the Use, Care and Protection of Abrasive Wheels (Tentative American Standard)
Safety Code for the Protection of Industrial Workers in Foundries (Tentative American Standard)
Safety Code for Power Presses and Foot and Hand Presses (Tentative American Standard)
Safety Code for Logging and Sawmill Machinery (Tentative American Standard)
Regulations for Electric Wiring and Apparatus in Relation to Fire Hazard ("National Electrical Code," 1923 edition, American Standard)
Electrical Safety Code ("National Electrical Safety Code"—American Standard)
Safety Code for the Protection of the Heads and Eyes of Industrial Workers (Tentative American Standard)
Safety Code for Laundry Machinery and Operations (American Standard)
Safety Code for Woodworking Plants (Tentative American Standard)
Safety Code for Elevators and Escalators (American Standard)

Codes on the following subjects of special interest to the industrial safety engineer are under preparation:

Building Exits
Construction Work
Railings and Toeboards for Floor and Wall Openings
Identification of Piping Systems
Walkway Surfaces
Mechanical Refrigeration
Machine Tools
Compressed-air Machinery
Conveyors and Conveying Machinery
Mechanical Power Control
Forging and Hot-metal Stamping
Rubber Machinery
Cranes, Derricks and Hoists
High-pressure Piping
Electrical Power Control
Protection against Lightning
Gas

Textiles
Paper and Pulp Mills
Tanneries
Industrial Sanitation
Ventilation
Exhaust Systems
Protection against Dust Explosions

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